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14 CARDIOVASCULAR ASSESSMENT

14.1 INTRODUCTION

14.1.1 Background

Animal research into the cardiotoxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (dioxin) has focused on acute biochemical and functional abnormalities associated with high-level exposure. In one study (1), rats were found to have reductions in pulse and blood pressure 6 days after administration of 40 µg/kg of dioxin by gavage and were less responsive to the chronotropic effect of isoproterenol, a beta-agonist. The authors of the study, noting a 66-percent reduction in serum thyroxine, postulated a down regulation of beta-receptors associated with the hypothyroid state rather than a direct cardiotoxic effect. Their findings were consistent with other studies that documented changes in myocardial beta-receptors with reduced serum indices of thyroid function and decreased beta-adrenergic responsiveness to isoproterenol in the ventricular papillary muscle of guinea pigs (2). Experiments into the effects of dioxin on myocardial contractility in rat (3) and guinea pig (4) atrial muscle have yielded mixed results; the primary cardiotoxic effects remain uncertain.

The biochemical effects of dioxin on cardiac muscle have been the subject of several reports. An increase in lipid peroxidation and a decrease in superoxide dismutase activity were noted in the hearts of female rats after dioxin administration (1). Dose-dependent decreases in adipose tissue lipoprotein lipase activity and hepatic low-density lipoprotein binding occurred in rabbits (5) and other laboratory animals (6) in association with elevated serum triglycerides. Electron microscopic studies have documented pre-atherosclerotic lesions in the aortic arch in association with these biochemical abnormalities (5) and dioxin exposure has been associated with intravascular thrombosis in rats (7). Two recent studies provide evidence that the developing vascular endothelium of fish embryos may be a target organ for dioxin toxicity (8, 9).

Numerous studies have focused on the effects of dioxin toxicity on lipid metabolism in experimental animals and may be relevant to herbicide exposure as a risk factor for the development of heart disease in man. Dioxin-induced hyperlipidemia has been documented in rats (10, 11), guinea pigs (12), and rabbits (5).

Numerous epidemiological studies have investigated cardiovascular mortality and morbidity in populations exposed to dioxin by occupation and consequent to industrial accidents (13–22). Other reports have examined similar endpoints in veterans who served in the Vietnam War (23–35). Some occupational (13, 20) and veterans' studies (23, 25, 26, 28–31) cited have shown no increase in cardiovascular mortality associated with exposure to dioxin, and several have documented a significant reduction in risk (23, 26, 27). However, in the 1994 Air Force Health Study (AFHS) mortality update (36), the Ranch Hand nonflying enlisted personnel were found to be at higher risk for death associated with circulatory disease than the Comparison nonflying enlisted personnel. Most occupational studies have found no increased risk for the development of cardiovascular disease related to dioxin exposure (13–16, 20). In two reports of the 1976 Seveso, Italy, industrial accident, dioxin exposure was associated with statistically significant increases in mortality because of coronary, cerebrovascular, and hypertensive vascular disease (18, 19).

The latest morbidity follow-up study of BASF Corporation employees highly exposed to dioxin during a chemical reactor incident in 1953 has been published (21). Almost half of the study group had

extrapolated serum dioxin levels of more than 1,000 parts per trillion (ppt). Across all exposure categories, there was no significant increase in the incidence of ischemic heart disease.

A more recently published retrospective cohort study examined cardiovascular mortality in 1,189 German chemical workers who had significant dioxin exposure in the 1950s (37). In this study, exposure was verified and subjects stratified into deciles based on serum and adipose tissue dioxin levels. There was a slight reduction in mortality risk at the two lowest levels of exposure, but a clear pattern of increasing risk for all-cause cardiovascular mortality and, particularly, for that associated with ischemic heart disease. The dose-response trend for both causes of mortality was significant ($p \leq 0.01$).

The well-established roles of diabetes mellitus and lipid disorders as risk factors in the development of cardiovascular disease have generated considerable interest in the potential intermediary role these metabolic indices might have on cardiovascular outcomes associated with dioxin exposure. Data and results from this (35, 38) and other epidemiological studies (22, 37, 39–44) are considered in the Gastrointestinal Assessment chapter (Chapter 13) and the Endocrine Assessment chapter (Chapter 16).

Previous AFHS examinations have shown mixed results with respect to cardiovascular endpoints. In the baseline and 1987 follow-up examinations, manual examination of the pulses revealed an increased prevalence of pulse deficits in the Ranch Hand cohort relative to Comparisons (45, 46), results noted as well in studies of residents exposed to dioxin in Times Beach, Missouri (47, 48). In the 1985 AFHS follow-up examination, which incorporated Doppler peripheral vascular studies into the protocol, no significant group differences were found (49). When the 1987 examination data were analyzed relative to serum dioxin levels, Ranch Hand participants in one high exposure category had higher percentages of peripheral pulse abnormalities by manual examination than did Comparisons (34). In addition, Ranch Hands with the highest current dioxin levels were at greater risk for the development of systemic arterial hypertension than were Comparisons. In contrast, there was a significant reduction in risk for the development of heart disease reported historically or by a verified medical records review.

In the 1992 follow-up examination, Ranch Hands were more likely than Comparisons to have elevated systolic blood pressures, and through 1990, there was an increase in cardiovascular disease mortality in the nonflying enlisted personnel. However, surviving Ranch Hands overall were found to be less at risk for the development of heart disease over time, and a significant inverse dose-response effect was noted with respect to the current body burden of dioxin (35).

14.1.2 Summary of Previous Analyses of the Air Force Health Study

14.1.2.1 1982 Baseline Study Summary Results

The 1982 baseline examination found no statistically significant differences between the Ranch Hand and Comparison groups in systolic or diastolic blood pressure, the frequency of abnormal electrocardiographs (ECGs), heart sound abnormalities, abnormal funduscopic findings, or carotid bruits. A statistically significant difference emerged in the frequency of abnormal peripheral pulses: 12.8 percent of the non-Black Ranch Hands exhibited absent or diminished peripheral pulses, compared to 9.4 percent of the non-Black Original Comparisons (p=0.05). No statistically significant differences were found between the two groups in the occurrence of reported or verified heart disease or heart attacks.

Greater than 80 percent of the cardiac conditions reported on the study questionnaire were verified by a detailed review of medical records. There was also a strong correlation between the past medical history of cardiac disease and the baseline examination cardiovascular findings, although the differences in peripheral pulse abnormalities occurred primarily in older individuals without a history of cardiovascular

disease. Finally, the well-known risk factors of age, smoking, and cholesterol were found to be correlated with each other and with several of the cardiovascular response variables.

14.1.2.2 1985 Follow-up Study Summary Results

The analysis of cardiovascular disease history did not reveal significant group differences in reported or verified hypertension, reported heart disease, or reported or verified heart attacks. There were no group differences in verified heart disease. The verified cardiovascular history and the central and peripheral cardiovascular abnormalities detected at the physical examination were correlated, supporting accuracy and validity of the cardiovascular measurements.

In the analyses of peripheral vascular function, no significant overall group differences were observed for abnormalities involving radial, femoral, popliteal, posterior tibial, dorsalis pedis, or three anatomic aggregates of these pulses (leg pulses, peripheral pulses, and all pulses), either by manual palpation or Doppler techniques. This overall finding was in distinct contrast to the 1982 baseline examination, which, by the manual palpation method, showed significant peripheral pulse deficits in Ranch Hands. This reversal in pulse findings over the two examinations may be attributed to the rigid 4-hour tobacco abstinence applied prior to Doppler testing, although other factors may have been involved.

14.1.2.3 1987 Follow-up Study Summary Results

The assessment of the central cardiac function also found the groups to be similar, although significantly fewer Ranch Hands than Comparisons had bradycardia and more Ranch Hands than Comparisons had arrhythmias (marginally significant).

For the peripheral vascular function, Ranch Hands had a higher or marginally higher mean or percent abnormal for diastolic blood pressure (continuous form), carotid bruits, femoral pulses, and dorsalis pedis pulses than did Comparisons. No difference between the two groups was detected in the discrete analysis of diastolic blood pressure. The percentage of radial pulse abnormalities was marginally higher in Comparisons than in Ranch Hands. On the three pulse indices (leg, peripheral, and all pulses), Ranch Hands had marginally or significantly higher percentages of abnormalities than did Comparisons.

14.1.2.4 Serum Dioxin Analysis of 1987 Follow-up Study Summary Results

The cardiovascular evaluation found a marginally significant association between initial dioxin and a decrease in the reported history of heart disease, and a significant negative association with verified history of heart disease. In addition, the analyses of categorized current dioxin also indicated a decrease in verified history of heart disease for Ranch Hands with the highest current dioxin levels relative to Comparisons with background levels. These Ranch Hands also had more essential hypertension by history (after removing the variables body fat and cholesterol from the model).

The analyses of the peripheral vascular function variables displayed significantly higher mean levels of diastolic blood pressure for Ranch Hands in the low and high categories than Comparisons (without adjustment for body fat). Similar to the analysis of systolic blood pressure, the discretized analysis of diastolic blood pressure did not display a significant association with dioxin within the low and high current dioxin categories. Ranch Hands generally exhibited a significant or marginally significant higher risk of absent femoral, dorsalis pedis, and posterior tibial pulses relative to Comparisons. These observations could represent a subclinical effect and emphasize the importance of continued follow-up and evaluation.

14.1.2.5 1992 Follow-up Study Summary Results

The cardiovascular evaluation found a marginally significant group difference for verified heart disease, excluding essential hypertension for enlisted flyers with Ranch Hands having a greater history of heart disease than Comparisons. Similar to the 1987 study, verified heart disease decreased significantly for increasing levels of current dioxin. Ranch Hands also displayed an increased history of essential hypertension for increasing levels of current dioxin.

A few other central cardiac function endpoints, including non-specific ST- and T-wave changes, right bundle branch block, and prior ECG evidence of myocardial infarction, displayed significant positive associations with current dioxin; none of these endpoints also displayed any group difference between Ranch Hands and Comparisons. These findings, in conjunction with the increase in the number of deaths caused by diseases of the circulatory system for Ranch Hand nonflying enlisted personnel based on the 1994 AFHS mortality update (34), showed potential associations with dioxin requiring further observation.

The analyses of the peripheral vascular function variables displayed significant group differences for the enlisted groundcrew stratum for a few of the pulse endpoints and significant differences between Ranch Hands in the high dioxin category and Comparisons. None of these associations was reinforced by a significant association with initial or current dioxin. Longitudinal analyses of the pulse endpoints also indicated that Ranch Hands in the enlisted groundcrew stratum and in the high initial dioxin category had a greater prevalence of pulse deficits since the 1985 follow-up examination than Comparisons. Again, these associations were not reinforced by a significant dose-response effect with initial dioxin.

In general, after reviewing the results of the cardiovascular assessment as a whole, the development of cardiovascular disease did not appear to be associated positively with dioxin. Dioxin associations with selected endpoints, as discussed above, together with mortality results, pointed to the need for further evaluation.

14.1.3   Parameters for the 1997 Cardiovascular Assessment

14.1.3.1 Dependent Variables

The analysis of the cardiovascular assessment was based on data collected from the 1997 questionnaire and physical examination and subsequent medical records verification. No laboratory examination data were analyzed as cardiovascular dependent variables, although data from the laboratory examination were used as covariates.

14.1.3.1.1   Medical Records Data

During the baseline, 1985, 1987, and 1992 AFHS examination health interviews, each participant was asked whether he had a heart condition. Medical records were sought to verify all reported conditions and to determine the time of occurrence of major cardiac events. In addition, the self-reported review-of-systems recorded the overall history of heart trouble and other serious illnesses. Data collected in a similar fashion at the 1997 follow-up was verified and combined with data from the four previous examinations to create a lifetime history for four conditions: essential hypertension, heart disease (excluding essential hypertension), myocardial infarction, and stroke or transient ischemic attack. Each of these conditions was classified as "yes" or "no" and analyzed.

International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes were used to construct the four conditions described above. The following ICD-9-CM codes were used: essential hypertension (ICD-9-CM codes 401.0-401.9), heart disease (excluding essential hypertension)

(ICD-9-CM codes 391.0-391.9, 392.0, 393.0-398.99, 402.0-402.91, 404.0-404.9, 410.0-417.9, and 420.0-429.9), myocardial infarction (ICD-9-CM codes 410.0-410.9, and 412), and stroke or transient ischemic attack (ICD-9-CM codes 435.0-436).

Participants with a verified pre-SEA heart condition were excluded from all analyses. A pre-SEA heart condition included pre-SEA myocardial infarction, but did not include pre-SEA essential hypertension. Participants with a verified pre-SEA history of essential hypertension also were excluded from the analysis of verified history of essential hypertension.

14.1.3.1.2   Physical Examination Data and Self-reported Questionnaire Data

Cardiovascular data analyzed from the 1997 physical examination were divided into two main categories: central cardiac function and peripheral vascular function.

14.1.3.1.2.1   Central Cardiac Function

The assessment of the central cardiac function at the cardiovascular examination was made by measurements of systolic blood pressure, diastolic blood pressure, heart sounds (by auscultation), and an ECG. Systolic and diastolic blood pressure were determined by a Critikon Dinamap 1846SXP® automated electronic monitor with the nondominant arm placed at heart level; the lowest diastolic pressure and the corresponding systolic pressure were recorded. Detection of abnormal heart sounds was conducted by standard auscultation with the participant placed in sitting, supine, and left lateral supine positions. Fourth heart sounds were assessed; murmurs were graded in intensity and location and were judged by the examiners to be functional (normal) or organic (abnormal) in nature. The standard 12-lead ECG was performed, and an additional strip in limb lead II was produced if any arrhythmia was found. Participants were asked to abstain from tobacco for at least 4 hours prior to the ECG because of the arterial constrictive effect of nicotine. The following items were considered to be abnormal: right bundle branch block, left bundle branch block, nonspecific ST- and T-wave changes, bradycardia (a resting pulse rate less than 50 beats per minute), tachycardia (a resting pulse rate greater than 100 beats per minute), arrhythmia (any irregularity of heart rhythm including premature beats but excluding normal sinus rhythm), evidence of a prior myocardial infarction, and other diagnoses (e.g., ventricular aneurysm, Wolff-Parkinson-White syndrome). Some arrhythmias (e.g., atrial flutter, atrial fibrillation, and junctional rhythm) required more evaluation and surveillance than others, but all were grouped together for evaluation in this study.

Variables analyzed in the evaluation of the central cardiac function included systolic blood pressure, diastolic blood pressure, heart sounds, an overall ECG assessment, and eight conditions associated with the ECG. These eight conditions were right bundle branch block, left bundle branch block, nonspecific ST- and T-wave changes, bradycardia, tachycardia, arrhythmia, evidence of a prior myocardial infarction, and other diagnoses. Both systolic and diastolic blood pressure were analyzed as a continuous variable and also as a discrete variable. Systolic blood pressure was classified as "normal" (≤140 mm Hg) and "high" (>140 mm Hg), and diastolic blood pressure was classified as "normal" (≤90 mm Hg) and "high" (>90 mm Hg). Participants with a verified pre-SEA heart condition were excluded from all analyses of the central cardiac function variables.

14.1.3.1.2.2 Peripheral Vascular Function

The peripheral vascular function was assessed during the cardiovascular examination by funduscopic examination of small vessels; presence or absence of carotid bruits; determination of the radial, femoral, popliteal, dorsalis pedis, and posterior tibial pulses by Doppler techniques; and a measure of intermittent claudication and vascular insufficiency.

The funduscopic examination was conducted with undilated pupils in a standard manner, with emphasis placed upon the detection of increased light reflex, arteriovenous nicking (a sign of chronic blood pressure elevation), hemorrhages, exudates, papilledema, and arteriolar spasm. The presence or absence of carotid bruits was assessed by auscultation over both carotid arteries.

The Doppler procedure for examining pulses is a progressive array of measurements designed to determine whether a pulse abnormality exists, where the obstruction is most likely located, and whether it has functional implications. The determination of a pulse abnormality was based upon an analysis of recorded Doppler waveform morphology. Pulsatility, systolic forward flow, diastolic reverse flow, and diastolic oscillations were examined.

The funduscopic examination, carotid bruits, and the five pulses also were dichotomized as "abnormal" or "normal" (or "presence" or "absence") and analyzed. Pulses were considered abnormal if no arterial flow or a monophasic arterial flow was present on either side. In addition, two pulse indices were constructed from the radial, femoral, popliteal, dorsalis pedis, and posterior tibial pulse measurements as follows:

- Leg pulses: femoral, popliteal, dorsalis pedis, and posterior tibial pulses

- Peripheral pulses: radial, femoral, popliteal, dorsalis pedis, and posterior tibial pulses.

Each of these indices was considered "normal" if all components were normal and "abnormal" if one or more pulses were abnormal.

In the 1997 questionnaire, each participant was asked the following questions:

- Do you get a pain in either or both of your legs while walking?

- Does this pain ever begin when you are standing still or sitting?

- Do you get this pain in either or both of your calf muscles?

The self-reported answers were used to detect intermittent claudication and vascular insufficiency (yes, no), which indicate an insufficient oxygen supply to the leg muscles. A participant was judged to have intermittent claudication and vascular insufficiency if he answered "yes" to the first and third questions and "no" to the second question. Participants with a verified pre-SEA heart condition were excluded from all analyses of the peripheral vascular function variables.

14.1.3.2 Covariates

A number of covariates were examined for inclusion in the adjusted analysis of the cardiovascular assessment. Many of these covariates are considered to be classical risk factors for chronic heart disease. Covariates examined included age, race, military occupation, lifetime alcohol history, current alcohol use, lifetime cigarette smoking history, current level of cigarette smoking, cholesterol, high-density lipoprotein (HDL), cholesterol-HDL ratio, body fat, personality type, family history of heart disease, family history of heart disease before the age of 45, diabetic class, and current use of blood pressure medication (for the blood pressure variables).

Age, race, and military occupation were determined from military records. Lifetime alcohol history was based on information from the 1997 questionnaire and combined with similar information gathered at the 1987 and 1992 follow-up examinations. Each participant was asked about his drinking patterns throughout his lifetime. When a participant's drinking patterns changed, he was asked to describe how his alcohol consumption differed and the duration of time that the drinking pattern lasted. The participant's average daily alcohol consumption was determined for each of the reported drinking pattern

periods throughout his lifetime, and an estimate of the corresponding total number of drink-years was derived. One drink-year was the equivalent of drinking 1.5 ounces of an 80-proof alcoholic beverage, one 12-ounce beer, or one 5-ounce glass of wine per day for 1 year.

Current cigarette smoking and lifetime cigarette smoking history were based on questionnaire data. For lifetime cigarette smoking history, the respondent's average smoking was estimated over his lifetime based on his responses to the 1997 questionnaire, with 1 pack-year defined as 365 packs of cigarettes smoked during a single year.

Cholesterol, HDL, and the cholesterol-HDL ratio were based on 1997 laboratory measurements. Body fat was calculated from a metric body mass index (50); the formula is

$$Body\ Fat\ (in\ percent) = \frac{Weight\ (kg)}{[Height\ (m)\ ]^2} \bullet\ 1.264 - 13.305.$$

Personality type was determined from the Jenkins Activity Survey administered during the 1997 follow-up examination and was derived from a discriminant-function equation based on questions that best discriminate men judged to be type A from those judged to be type B (51). Positive scores reflected the type A direction and negative scores reflected the type B direction. Personality type was dichotomized as type A or type B.

Family history of heart disease was defined as "yes" if the participant's mother, father, sister(s), or brother(s) had heart trouble or heart disease and "no" otherwise. Family history of heart disease before the age of 45 was defined as "yes" if the participant's mother, father, sister(s), or brother(s) had heart trouble or heart disease before the age of 45 and "no" otherwise. Blood pressure medication (yes, no) was used as a covariate for the adjusted analysis of the systolic and diastolic blood pressure variables only.

Diabetic class was used as a covariate in the analysis of the 1997 follow-up. Diabetes is a known risk factor for cardiovascular disease. In the 1997 questionnaire, a general screening question on diabetes was posed. Each participant was asked during the in-person health interview the following question: "Since the date of the last interview, has a doctor told you for the first time that you had diabetes?" All affirmative responses were verified by a medical records review and added to previously reported and verified information on diabetes from the 1982 baseline and the 1985, 1987, and 1992 follow-up examinations for each participant. Participants with a verified history of diabetes were combined with those participants with a 2-hour postprandial glucose level of 200 mg/dl or greater at the 1997 physical examination and classified as "diabetic" for the diabetic class covariate. Those participants without a verified history of diabetes and with a 2-hour postprandial glucose level of less than 200 mg/dl at the 1997 physical examination were classified as either "impaired" (140 mg/dl ≤ 2-hour postprandial glucose < 200 mg/dl) or "normal" (2-hour postprandial glucose < 140 mg/dl).

The current use of blood pressure medication was used as a covariate for the adjusted analysis of systolic and diastolic blood pressures. This information was reported by the participant on a self-reported form that listed physicians and medications, and through a question in the in-person interview.

The following dependent variables—essential hypertension, heart disease excluding essential hypertension, myocardial infarction, and stroke or transient ischemic attack—capture a history of a cardiovascular condition rather than the current state of a participant's life at the time of the physical examination. Consequently, to reflect the historical nature of these dependent variables, lifetime alcohol history and lifetime cigarette smoking history were used as covariates, but current alcohol use and current cigarette smoking were not. Lifetime alcohol history and lifetime cigarette smoking history reflect the

cumulative lifetime effects of alcohol use and tobacco, respectively, whereas current alcohol use and current cigarette smoking emphasize the short period of time near the date of the physical examination.

14.1.4   Statistical Methods

Table 14-1 summarizes the statistical analysis performed for the cardiovascular assessment. The first part of this table describes the dependent variables and identifies the covariates and the statistical methods. The second part of this table further describes the covariates. A covariate was used in its continuous form whenever possible for all adjusted analyses. If a covariate was inherently discrete (e.g., military occupation), or if a categorized form was needed to develop measures of association with the dependent variables, the covariate was categorized as shown in Table 14-1.

Table 14-2 provides a summary of the number of participants with missing dependent variable or covariate data. In addition, the number of participants excluded from analysis is given.

Table 14-1. Statistical Analysis for the Cardiovascular Assessment

Dependent Variables

Variable (Units)	Data Source	Data Form	Cutpoints	Covariates[a]	Exclusions[b]	Statistical Analysis and Methods
Essential Hypertension	MR-V	D	Yes No	(1)	(a)	U:LR A:LR
Heart Disease (Excluding Essential Hypertension)	MR-V	D	Yes No	(1)	(b)	U:LR A:LR
Myocardial Infarction	MR-V	D	Yes No	(1)	(b)	U:LR A:LR
Stroke or Transient Ischemic Attack	MR-V	D	Yes No	(1)	(b)	U:LR,CS A:LR
Systolic Blood Pressure (mm Hg)	PE	D/C	High: >140 Normal: ≤140	(2)	(b)	U:LR,GLM A:LR,GLM L:LR,GLM
Diastolic Blood Pressure (mm Hg)	PE	D/C	High: >90 Normal: ≤90	(2)	(b)	U:LR,GLM A:LR,GLM
Heart Sounds	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR
Overall Electrocardiograph (ECG)	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR
ECG: Right Bundle Branch Block	PE	D	Yes No	(3)	(b)	U:LR A:LR
ECG: Left Bundle Branch Block	PE	D	Yes No	(3)	(b)	U:LR,CS A:LR
ECG: Non-specific ST-and T-Wave Changes	PE	D	Yes No	(3)	(b)	U:LR A:LR
ECG: Bradycardia	PE	D	Yes No	(3)	(b)	U:LR A:LR
ECG: Tachycardia	PE	D	Yes No	(3)	(b)	U:LR,CS A:LR

Variable (Units)	Data Source	Data Form	Cutpoints	Covariates[a]	Exclusions[b]	Statistical Analysis and Methods
ECG: Arrhythmia	PE	D	Yes No	(3)	(b)	U:LR A:LR
ECG: Evidence of Prior Myocardial Infarction	PE	D	Yes No	(3)	(b)	U:LR A:LR
ECG: Other Diagnoses	PE	D	Yes No	(3)	(b)	U:LR,CS A:LR
Funduscopic Examination	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR
Carotid Bruits	PE	D	Present Absent	(3)	(b)	U:LR A:LR
Radial Pulses	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR
Femoral Pulses	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR L:LR
Popliteal Pulses	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR L:LR
Dorsalis Pedis Pulses	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR L:LR
Posterior Tibial Pulses	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR L:LR
Leg Pulses	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR L:LR
Peripheral Pulses	PE	D	Abnormal Normal	(3)	(b)	U:LR A:LR L:LR
Intermittent Claudication and Vascular Insufficiency (ICVI) Index	Q-SR	D	Abnormal Normal	(3)	(b)	U:LR A:LR

[a]Covariates:
(1): age, race, military occupation, lifetime cigarette smoking history, lifetime alcohol history, cholesterol, HDL, cholesterol-HDL ratio, diabetic class, body fat, personality type, family history of heart disease, family history of heart disease before age 45.
(2): age, race, military occupation, lifetime cigarette smoking history, current cigarette smoking, lifetime alcohol history, current alcohol use, cholesterol, HDL, cholesterol-HDL ratio, diabetic class, body fat, personality type, family history of heart disease, family history of heart disease before age 45, taking blood pressure medication.
(3): age, race, military occupation, lifetime cigarette smoking history, current cigarette smoking, lifetime alcohol history, current alcohol use, cholesterol, HDL, cholesterol-HDL ratio, diabetic class, body fat, personality type, family history of heart disease, family history of heart disease before age 45.

[b]Exclusions:
(a): participants with a pre-SEA heart condition, participants with pre-SEA essential hypertension.
(b): participants with a pre-SEA heart condition.

Covariates

Variable (Units)	Data Source	Data Form	Cutpoints
Age (years)	MIL	D/C	Born ≥1942 Born <1942
Race	MIL	D	Black Non-Black
Occupation	MIL	D	Officer Enlisted Flyer Enlisted Groundcrew
Lifetime Alcohol History (drink-years)	Q-SR	D/C	0 >0–40 >40
Current Alcohol Use (drinks/day)	Q-SR	D/C	0–1 >1–4 >4
Lifetime Cigarette Smoking History (pack-years)	Q-SR	D/C	0 >0–10 >10
Current Cigarette Smoking (cigarettes/day)	Q-SR	D/C	0-Never 0-Former >0–20 >20
Cholesterol (mg/dl)	LAB	D/C	≤200 >200–239 >239
High Density Lipoprotein (mg/dl)	LAB	D/C	0–35 >35
Cholesterol-HDL Ratio	LAB	D/C	0–5 >5
Body Fat (percent)	PE	D/C	Obese: >25% Lean or Normal: ≤25%
Personality Type	PE	D	A direction B direction
Family History of Heart Disease	Q-SR	D	Yes No
Family History of Heart Disease Before Age 45	Q-SR	D	Yes No
Diabetic Class	LAB/MR-V	D	• Diabetic: past history or ≥200 mg/dl 2-hr. postprandial glucose • Impaired: 140–<200 mg/dl 2-hr. postprandial glucose • Normal: <140 mg/dl 2-hr. postprandial glucose
Taking Blood Pressure Medication	Q-SR/MR-V	D	Yes No

Table 14-1. Statistical Analysis for the Cardiovascular Assessment (Continued)

Abbreviations

Data Source: LAB: 1997 laboratory results
                    MIL: Air Force military records
                    MR-V: Medical records (verified)
                    PE: 1997 physical examination
                    Q-SR: Health questionnaires (self-reported)

Data Form: D: Discrete analysis only
                    D/C: Discrete and continuous analyses for dependent variables; appropriate form for analysis
                         (either discrete or continuous) for covariates

Statistical Analysis: U: Unadjusted analysis
                    A: Adjusted analysis
                    L: Longitudinal analysis

Statistical Methods: CS: Chi-square contingency table analysis (continuity-adjusted)
                    GLM: General linear models analysis
                    LR: Logistic regression analysis

Table 14-2. Number of Participants Excluded or with Missing Data for the Cardiovascular Assessment

Variable	Variable Use	Group		Dioxin (Ranch Hands Only)		Categorized Dioxin	
		Ranch Hand	Comparison	Initial	1987	Ranch Hand	Comparison
Funduscopic Examination	DEP	1	1	0	1	1	1
Femoral Pulses	DEP	0	1	0	0	0	1
Popliteal Pulses	DEP	0	2	0	0	0	2
Dorsalis Pedis Pulses	DEP	0	2	0	0	0	2
Posterior Tibial Pulses	DEP	0	4	0	0	0	4
Leg Pulses	DEP	0	4	0	0	0	4
Peripheral Pulses	DEP	0	4	0	0	0	4
Intermittent Claudication and Insufficiency Index	DEP	1	0	0	1	1	0
Lifetime Alcohol History	COV	6	2	3	6	6	1
Current Alcohol Use	COV	1	0	0	1	1	0
Lifetime Cigarette Smoking History	COV	2	1	1	2	2	1
Current Cigarette Smoking	COV	1	0	0	1	1	0
HDL Cholesterol	COV	1	1	1	1	1	1
Cholesterol-HDL Ratio	COV	1	1	1	1	1	1
Personality Type	COV	3	0	1	3	3	0
Family History of Heart Disease	COV	10	6	5	10	10	6
Family History of Heart Disease Before Age 45	COV	22	22	11	22	22	21
Diabetic Class	EXC	9	18	5	7	7	17

		Group		Dioxin (Ranch Hands Only)		Categorized Dioxin	
Variable	Variable Use	Ranch Hand	Comparison	Initial	1987	Ranch Hand	Comparison
Pre-SEA Heart Condition	EXC	11	19	6	11	11	18
Pre-SEA Essential Hypertension	EXC	11	14	7	11	11	14

Note: DEP = Dependent variable.
COV = Covariate.
EXC = Exclusion.
870 Ranch Hands and 1,251 Comparisons.
482 Ranch Hands for initial dioxin; 863 Ranch Hands for 1987 dioxin.
863 Ranch Hands and 1,213 Comparisons for categorized dioxin.

14.1.4.1 Longitudinal Analysis

The cardiovascular longitudinal analysis was based on the association of exposure with changes in systolic blood pressure between the 1982 and 1997 examinations and six pulse measurements between the 1985 and 1997 examinations. The longitudinal analysis for systolic blood pressure was based on this variable in both the continuous and discrete forms. The six pulse measurements included femoral pulses, popliteal pulses, dorsalis pedis pulses, posterior tibial pulses, leg pulses, and peripheral pulses. The 1985 and 1997 measurements were used for the pulse assessments because the Doppler assessment of pulses was conducted at these two examinations and was not conducted at the 1982 baseline examination.

14.2 RESULTS

14.2.1 Dependent Variable-Covariate Associations

The associations between the dependent variables examined in the cardiovascular assessment and the covariates used in the adjusted analysis were investigated; the results are presented in Appendix F, Table F-6. These associations are pairwise between the dependent variable and the covariate and are not adjusted for any other covariates. Participants with a pre-SEA heart condition were excluded from all analyses. In addition, participants with pre-SEA essential hypertension were excluded from the analysis of essential hypertension.

Tests of covariate association showed age ($p=0.001$), lifetime alcohol history ($p=0.001$), cholesterol-HDL ratio ($p=0.005$), body fat ($p=0.001$), personality type ($p=0.039$), family history of heart disease ($p=0.001$), family history of heart disease before age 45 ($p=0.003$), and diabetic class ($p=0.001$) to be significantly associated with essential hypertension. Older participants had more essential hypertension than did younger participants (48.0% versus 32.9%). Essential hypertension was highest for the heaviest drinkers (in terms of drink-years) (48.2%), followed by participants who did not drink (39.0%), then moderate drinkers (38.5%). Essential hypertension increased with the cholesterol-HDL ratio and body fat. Participants with personality type B had a higher percentage of essential hypertension than did type A participants (43.0% versus 38.4%). Essential hypertension occurred more often for participants who had a family history of heart disease and for participants who had a family history of heart disease before age 45. Essential hypertension was greatest for diabetics (59.4%), followed by participants in the impaired diabetic class (52.4%), then participants classified as normal (34.6%).

Heart disease (excluding essential hypertension) was significantly associated with age (p=0.001), occupation (p=0.001), cholesterol (p=0.001), family history of heart disease (p=0.001), family history of heart disease before age 45 (p=0.018), and diabetic class (p=0.009). Heart disease increased with age and decreased with cholesterol level. Officers had the highest percentage of heart disease (68.7%), followed by enlisted flyers (66.6%), then enlisted groundcrew (56.7%). Participants with a family history of heart disease had more heart disease (66.6% versus 57.4%). Likewise, participants with a family history of heart disease before age 45 had more heart disease (69.9% versus 62.0%). Diabetic participants had the most heart disease (69.5%), followed by participants in the impaired diabetic class (64.1%), then participants classified as normal (60.8%).

The percentage of participants with a history of a myocardial infarction increased significantly with age (p=0.001) and lifetime cigarette smoking history (p=0.001), while decreasing significantly with cholesterol (p=0.001) and HDL cholesterol (p=0.012). The association with diabetic class was also significant (p=0.001). Participants in the normal diabetic class had the lowest percentage of participants with a myocardial infarction (6.8%), followed by participants in the impaired diabetic class (9.9%), then diabetics (14.2%).

Systolic blood pressure in its continuous form increased with age (p<0.001), lifetime alcohol history (p<0.001), lifetime cigarette smoking history (p=0.045), cholesterol (p=0.012), the cholesterol-HDL ratio (p=0.005), and body fat (p<0.001). Systolic blood pressure decreased significantly with current cigarette smoking (p=0.004). Tests of covariate associations also showed significant relations with occupation (p=0.005), diabetic class (p<0.001), and blood pressure medication (p<0.001). Enlisted flyers had the highest mean systolic blood pressure levels (127.1 mm Hg), followed by officers (126.1 mm Hg), then enlisted groundcrew (123.9 mm Hg). Participants in the normal diabetic class had the lowest mean systolic blood pressure levels (123.0 mm Hg), followed by participants in the impaired diabetic class (129.3 mm Hg), then diabetic participants (131.8 mm Hg). Participants taking blood pressure medication had a higher mean systolic blood pressure level (128.6 mm Hg) than those not taking blood pressure medication (123.9 mm Hg).

Systolic blood pressure in its dichotomous form increased with age (p=0.001), cholesterol (p=0.025), the cholesterol-HDL ratio (p=0.028), and body fat (p=0.001). Significant associations also were seen between systolic blood pressure and occupation (p=0.029), family history of heart disease (p=0.008), diabetic class (p=0.001), and blood pressure medication (p=0.001). Enlisted flyers had the greatest percentage of high systolic blood pressure values (23.6%), followed by officers (23.2%), then enlisted groundcrew (18.6%). Participants with a family history of heart disease had a greater prevalence of high systolic blood pressure values than did participants with no history of heart disease (23.3% versus 18.3%). Diabetic participants had the largest percentage of high systolic blood pressure values (31.9%), followed by participants in the impaired diabetic class (28.6%), then participants classified as normal (17.1%). Participants taking blood pressure medication had a greater prevalence of high systolic blood pressure values than participants not taking blood pressure medication (27.6% versus 18.5%).

Diastolic blood pressure in its continuous form decreased with age (p=0.009), lifetime cigarette smoking history (p=0.003), and current cigarette smoking (p=0.001). Diastolic blood pressure increased with cholesterol (p<0.001), the cholesterol-HDL ratio (p=0.004), and body fat (p<0.001). Race and diabetic class were also significantly associated with diastolic blood pressure (p=0.010 and p=0.030, respectively). Black participants had a higher mean diastolic blood pressure than non-Black participants (76.69 mm Hg versus 74.46 mm Hg). Participants in the impaired diabetic class had the highest mean diastolic blood pressure (75.94 mm Hg), followed by diabetic participants (74.41 mm Hg), then participants classified as normal (74.32 mm Hg).

Tests of covariate association for diastolic blood pressure in its discrete form showed significant relations with lifetime cigarette smoking history (p=0.003) and blood pressure medication (p=0.004). Moderate lifetime cigarette smokers (in terms of pack-years) had the greatest percentage of high diastolic blood pressure values (7.8%), followed by participants who never smoked and participants who were the heaviest smokers (4.1% each). Participants taking blood pressure medication had a greater prevalence of high diastolic blood pressure values than did participants not taking blood pressure medication (7.3% versus 4.1%).

The percentage of participants with abnormal heart sounds increased with age (p=0.001). Current cigarette smoking was also significantly associated with heart sounds (p=0.030). Former smokers had the highest prevalence of abnormal heart sounds (5.7%), followed by participants who smoked up to 20 cigarettes per day (3.4%), participants who smoked more than 20 cigarettes per day (2.9%), and participants who never smoked (2.9%).

The prevalence of abnormal overall ECG results increased with age (p=0.001) and body fat (p=0.008), while decreasing with cholesterol (p=0.041). Also significant were occupation (p=0.001), lifetime cigarette smoking history (p=0.002), current cigarette smoking (p=0.028), personality type (p=0.011), family history of heart disease (p=0.001), and diabetic class (p=0.001). Enlisted flyers had the highest percentage of abnormal overall ECG results (36.4%), followed by officers (34.6%), then enlisted groundcrew (26.3%). Heavy lifetime cigarette smokers (in terms of pack-years) had the highest percentage of abnormal overall ECG results (35.0%), followed by participants who never smoked (28.3%), then moderate lifetime cigarette smokers (27.6%). Participants who currently smoked up to 20 cigarettes per day had the highest percentage of abnormal overall ECG results (35.0%), followed by former smokers (32.8%), participants who never smoked (28.3%), and participants who smoked more than 20 cigarettes per day (23.5%). Participants with type B personalities had a higher percentage of abnormal overall ECG results (33.2%) than did participants with type A personalities (27.8%). Participants with a family history of heart disease had a higher prevalence of abnormal overall ECG results than did participants with no family history of heart disease (35.3% versus 24.6%). Diabetic participants had the highest percentage of abnormal overall ECG results (46.7%), followed by participants in the impaired diabetic class (37.0%), then participants classified as normal (26.4%).

The prevalence of right bundle branch block increased significantly with age (p=0.001). Also significantly associated with right bundle branch block were occupation (p=0.040), lifetime cigarette smoking history (p=0.048), and diabetic class (p=0.001). Enlisted flyers had the highest prevalence of right bundle branch block (4.5%), followed by officers (2.6%), then enlisted groundcrew (1.9%). Heavy lifetime cigarette smokers had the highest prevalence of right bundle branch block (3.5%), followed by nonsmokers (2.2%), then moderate lifetime smokers (1.5%). Diabetic participants had the highest percentage of right bundle branch block (5.4%), followed by participants in the impaired diabetic class (2.6%), then participants classified as normal (1.9%).

The percentage of non-specific ST- and T-wave changes increased with age (p=0.001) and body fat (p=0.001), while decreasing with lifetime alcohol use (p=0.024). Family history of heart disease (p=0.001) and diabetic class (p=0.001) also were significant. Participants with a family history of heart disease had a higher percentage of non-specific ST- and T-wave changes than did participants with no history (21.1% versus 14.0%). Diabetic participants had the highest prevalence of non-specific ST- and T-wave changes (29.3%), followed by participants in the impaired diabetic class (24.5%), then participants classified as normal (14.6%).

The prevalence of bradycardia increased significantly with HDL cholesterol levels (p=0.043), while decreasing with the cholesterol-HDL ratio (p=0.005) and body fat (p=0.001). Occupation and diabetic

class also were significantly related to bradycardia (p=0.001 each). Officers had the highest prevalence of bradycardia (5.6%), followed by enlisted flyers (3.0%), then enlisted groundcrew (1.8%). Participants in the normal diabetic class had the highest prevalence of bradycardia (4.5%), followed by diabetic participants (1.7%), then participants in the impaired diabetic class (0.4%).

Tachycardia was significantly associated with lifetime alcohol history (p=0.029) and diabetic class (p=0.008). Non-drinkers had the highest prevalence of tachycardia (1.7%), followed by heavy drinkers (0.8%), then moderate lifetime alcohol drinkers (0.2%). Diabetic participants had the highest prevalence of tachycardia (1.4%), followed by participants in the impaired diabetic class (0.4%), then participants classified as normal (0.2%).

The percentage of participants with arrhythmia increased with age (p=0.001).

Evidence of prior myocardial infarction from the ECG increased with age (p=0.001) and decreased with cholesterol levels (p=0.007). Lifetime cigarette smoking history (p=0.003) and diabetic class (p=0.001) also were significantly associated with prior myocardial infarction. Heavy lifetime cigarette smokers had the highest prevalence of a prior myocardial infarction (5.8%), followed by nonsmokers (2.9%), then moderate lifetime cigarette smokers (2.7%). Diabetic participants had the highest percentage of participants with evidence of a prior myocardial infarction (9.4%), followed by participants in the impaired diabetic class (5.1%), then participants classified as normal (2.8%).

The prevalence of abnormal funduscopic examination results increased with age (p=0.001), lifetime cigarette smoking history (p=0.001), and body fat (p=0.004). Occupation (p=0.001), current cigarette smoking (p=0.019), personality type (p=0.001), and diabetic class (p=0.001) were also significantly associated with an abnormal funduscopic examination. Enlisted flyers had the highest percentage of abnormal funduscopic examination results (18.6%), followed by enlisted groundcrew (11.5%), then officers (11.1%). Participants who never smoked had the lowest percentage of abnormal funduscopic exam results (8.9%), followed by participants who currently smoked up to 20 cigarettes per day (13.5%), former smokers (14.0%), and participants who currently smoked more than 20 cigarettes per day (14.1%). Abnormal funduscopic examinations were more prevalent for participants with personality type B than those with personality type A (14.4% versus 9.2%). Diabetic participants had the highest percentage of abnormal funduscopic exam results (20.0%), followed by participants in the impaired diabetic class (14.3%), then participants classified as normal (10.3%).

The percentage of participants with carotid bruits present increased with age (p=0.001) and lifetime cigarette smoking history (p=0.003). Current cigarette smoking and diabetic class also were significantly associated with carotid bruits (p=0.023 and p=0.007, respectively). Participants who currently smoked up to 20 cigarettes per day had the highest percentage of carotid bruits present (4.1%), followed by participants who currently smoked more than 20 cigarettes per day (3.7%), former smokers (3.1%), and participants who never smoked (1.0%). Diabetic participants had the highest prevalence of carotid bruits (5.1%), followed by participants in the impaired diabetic class (2.9%), then participants classified as normal (2.1%).

Tests of covariate association showed race (p=0.018), lifetime alcohol history (p=0.006), current alcohol use (p=0.005), and current cigarette smoking (p=0.010) to be significantly associated with abnormal radial pulses. The prevalence of abnormal results increased with lifetime alcohol use. Black participants had a higher percentage of abnormal radial pulses than non-Blacks (2.4% versus 0.4%). Participants who currently were moderate drinkers (in terms of drinks per day) had the highest percentage of abnormal radial pulses (1.6%), followed by light drinkers (0.3%), then participants who were the heaviest drinkers (0.0%). Participants who currently smoked up to 20 cigarettes per day had the highest percentage of

abnormal radial pulses (1.9%), followed by participants who currently smoked more than 20 cigarettes per day (0.7%), former smokers (0.4%), and participants who never smoked (0.2%).

The prevalence of abnormal femoral pulses increased with age (p=0.009), lifetime alcohol history (p=0.002), and lifetime cigarette smoking history (p=0.002). Also significant were current alcohol use (p=0.001), current cigarette smoking (p=0.001), and diabetic class (p=0.003). Participants who were currently moderate drinkers had the highest percentage of abnormal femoral pulses (4.4%), followed by the heaviest drinkers (4.0%), then the light drinkers (1.0%). Participants who currently smoked up to 20 cigarettes per day had the highest percentage of abnormal femoral pulses (4.9%), followed by participants who currently smoked more than 20 cigarettes per day (4.4%), former smokers (1.2%), and participants who never smoked (0.3%). Diabetic participants had the highest percentage of abnormal femoral pulses (3.7%), followed by participants classified as normal (1.2%), then participants in the impaired diabetic class (1.1%).

The percentage of participants with abnormal popliteal pulses increased with age (p=0.001), lifetime alcohol history (p=0.013), current alcohol use (p=0.002), lifetime cigarette smoking history (p=0.001), and current cigarette smoking (p=0.001). The association with diabetic class also was significant (p=0.001). Participants who were currently moderate drinkers had the highest percentage of abnormal popliteal pulses (4.9%), followed by the heaviest drinkers (4.0%), then participants who were the lightest drinkers (1.9%). Participants who currently smoked up to 20 cigarettes per day had the highest percentage of abnormal popliteal pulses (7.1%), followed by participants who currently smoked more than 20 cigarettes per day (5.1%), former smokers (2.0%), and participants who never smoked (0.5%). Diabetic participants had the highest percentage of abnormal popliteal pulses (6.0%), followed by participants in the impaired diabetic class (1.8%), then participants classified as normal (1.7%).

The prevalence of abnormal dorsalis pedis pulses increased with age (p=0.001), lifetime cigarette smoking history (p=0.001), and current cigarette smoking (p=0.001). Lifetime alcohol history and diabetic class also were significant (p=0.009 and p=0.001, respectively). Heavy lifetime alcohol drinkers had the highest percentage of abnormal dorsalis pedis pulses (10.6%), followed by non-drinkers (8.5%), then moderate lifetime alcohol drinkers (6.6%). Diabetic participants had the highest prevalence of abnormal dorsalis pedis pulses (14.0%), followed by participants classified as normal (6.7%), then participants in the impaired diabetic class (5.5%).

The percentage of abnormal posterior tibial pulses increased with age (p=0.001), lifetime alcohol history (p=0.027), current alcohol use (p=0.003), lifetime cigarette smoking history (p=0.001), and current cigarette smoking (p=0.001). Personality type and diabetic class also were significantly associated with posterior tibial pulses (p=0.020 and p=0.001, respectively). Participants with type B personalities had more abnormal posterior tibial pulses than participants with type A personalities (6.7% versus 4.2%). Diabetic participants had the highest prevalence of abnormal posterior tibial pulses (13.4%), followed by participants in the impaired diabetic class (5.5%), then participants classified as normal (4.1%).

Abnormal leg pulses increased with age (p=0.001), lifetime cigarette smoking history (p=0.001), and current cigarette smoking (p=0.001). Occupation (p=0.044), lifetime alcohol history (p=0.013), and personality type (p=0.012) also were associated significantly with leg pulses. Enlisted flyers had the highest percentage of abnormal leg pulses (14.2%), followed by enlisted groundcrew (10.0%), then officers (9.3%). Heavy lifetime alcohol drinkers had the highest percentage of abnormal leg pulses (13.4%), followed by non-drinkers (11.0%), then moderate lifetime alcohol drinkers (9.0%). Participants with type B personalities had more abnormal leg pulses than participants with type A personalities (11.7% versus 8.2%). Diabetic participants had the highest prevalence of abnormal leg pulses (18.8%),

followed by participants classified as normal (8.7%), then participants in the impaired diabetic class (8.4%).

The prevalence of abnormal peripheral pulses increased with age (p=0.001), lifetime cigarette smoking history (p=0.001), and current cigarette smoking (p=0.001), while decreasing with body fat (p=0.034). Lifetime alcohol history (p=0.005), current alcohol use (p=0.036), personality type (p=0.026), and diabetic class (p=0.001) also were associated significantly with abnormal peripheral pulses. Heavy lifetime alcohol drinkers had the highest percentage of abnormal peripheral pulses (14.0%), followed by non-drinkers (11.0%) and moderate lifetime alcohol drinkers (9.1%). Participants who were currently moderate drinkers had the highest percentage of abnormal peripheral pulses (14.2%), followed by the heaviest drinkers (14.0%), then participants who were the lightest drinkers (9.8%). Participants with type B personalities had a higher percentage of abnormal peripheral pulses than did participants with type A personalities (11.8% versus 8.7%). Diabetic participants had the highest prevalence of abnormal peripheral pulses (19.4%), followed by participants classified as normal (8.9%), then participants in the impaired diabetic class (8.4%).

The percentage of abnormal intermittent claudication and vascular insufficiency index (ICVI) results increased with lifetime cigarette smoking (p=0.001) and current cigarette smoking (p=0.001). Diabetic class was also significant (p=0.001). Diabetic participants had the highest percentage of abnormal ICVI results (9.1%), followed by participants in the impaired diabetic class (2.9%), then participants classified as normal (2.6%).

14.2.2   Exposure Analysis

The following section presents results of the statistical analysis of the dependent variables shown in Table 14-1. Dependent variables were derived from a medical records review and verification, physical examination and ECG determinations, and an ICVI index based on participant responses to three questions regarding leg pain.

Four models were examined for each dependent variable given in Table 14-1. The analyses of these models are presented below. Further details on dioxin and the modeling strategy are found in Chapters 2 and 7, respectively. These analyses were performed both unadjusted and adjusted for relevant covariates. Model 1 examined the relation between the dependent variable and group (i.e., Ranch Hand or Comparison). In this model, exposure was defined as "yes" for Ranch Hands and "no" for Comparisons without regard to the magnitude of the exposure. As an attempt to quantify exposure, three contrasts of Ranch Hands and Comparisons were performed along with the overall Ranch Hand versus Comparison contrast. These three contrasts compared Ranch Hands and Comparisons within each occupational category (i.e., officers, enlisted flyers, and enlisted groundcrew). As described in previous reports and Table 2-8, the average levels of exposure to dioxin were highest for enlisted groundcrew, followed by enlisted flyers, then officers.

Model 2 explored the relation between the dependent variable and an extrapolated initial dioxin measure for Ranch Hands who had a 1987 dioxin measurement greater than 10 ppt. If a participant did not have a 1987 dioxin level, the 1992 level was used to estimate the initial dioxin level. If a participant did not have a 1987 or a 1992 dioxin level, the 1997 level was used to estimate the initial dioxin level. A statistical adjustment for the percentage of body fat at the time of the participant's blood measurement of dioxin was included in this model to account for body-fat-related differences in elimination rate (52).

Model 3 divided the Ranch Hands examined in Model 2 into two categories based on their initial dioxin measures. These two categories are referred to as "low Ranch Hand" and "high Ranch Hand." Two

additional categories, Ranch Hands with 1987 serum dioxin levels at or below 10 ppt and Comparisons with 1987 serum dioxin levels at or below 10 ppt, were formed and included in the model. Ranch Hands with 1987 serum dioxin levels at or below 10 ppt are referred to as the "background Ranch Hand" category. Dioxin levels in 1992 were used if the 1987 level was not available, and dioxin levels in 1997 were used if the 1987 and 1992 levels were not available. These four categories—Comparisons, background Ranch Hands, low Ranch Hands, and high Ranch Hands—were used in Model 3 analyses. The relation between the dependent variable in each of the three Ranch Hand categories and the dependent variable in the Comparison category was examined. A fourth contrast, exploring the relation of the dependent variable in the combined low and high Ranch Hand categories relative to Comparisons, also was conducted. This combination is referred to in the tables as the "low plus high Ranch Hand" category. As in Model 2, a statistical adjustment for the percentage of body fat at the time of the participant's blood measurement of dioxin was included in this model.

Model 4 examined the relation between the dependent variable and 1987 lipid-adjusted dioxin levels in all Ranch Hands with a dioxin measurement. If a participant did not have a 1987 dioxin measurement, the 1992 measurement was used to determine the dioxin level. If a participant did not have a 1987 or a 1992 dioxin measurement, the 1997 measurement was used to determine the dioxin level.

14.2.2.1 Medical Records Variables

14.2.2.1.1   Essential Hypertension

All Model 1, 2, and 3 analyses of essential hypertension revealed no significant results (Table 14-3(a–f): p>0.13 for each analysis).

The unadjusted and adjusted Model 4 analyses each showed significant positive associations between essential hypertension and 1987 dioxin (Table 14-3(g,h): Est. RR=1.22, p<0.001; Adj. RR=1.18, p=0.011). The percentages of participants with essential hypertension in the low, medium, and high 1987 dioxin categories were 34.0, 38.0, and 49.1, respectively.

Table 14-3. Analysis of Essential Hypertension

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*850*	*345 (40.6)*	*0.95 (0.80,1.14)*	*0.606*
	Comparison	*1,220*	*509 (41.7)*		
Officer	Ranch Hand	329	128 (38.9)	0.90 (0.68,1.20)	0.467
	Comparison	480	199 (41.5)		
Enlisted Flyer	Ranch Hand	149	71 (47.7)	1.18 (0.77,1.83)	0.447
	Comparison	184	80 (43.5)		
Enlisted Groundcrew	Ranch Hand	372	146 (39.2)	0.92 (0.70,1.20)	0.519
	Comparison	556	230 (41.4)		

Table 14-3. Analysis of Essential Hypertension (Continued)

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.96 (0.79,1.17)*	*0.708*
Officer	0.85 (0.63,1.16)	0.317
Enlisted Flyer	1.27 (0.79,2.04)	0.316
Enlisted Groundcrew	0.96 (0.72,1.29)	0.811

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	152	65 (42.8)	1.06 (0.91,1.23)	0.441
Medium	160	72 (45.0)		
High	159	77 (48.4)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
452	1.10 (0.91,1.32)	0.314

[a] Relative risk for a twofold increase in initial dioxin.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,183	490 (41.4)		
Background RH	372	127 (34.1)	0.86 (0.67,1.11)	0.246
Low RH	229	94 (41.0)	0.95 (0.71,1.29)	0.758
High RH	242	120 (49.6)	1.22 (0.91,1.63)	0.177
Low plus High RH	471	214 (45.4)	1.08 (0.87,1.35)	0.488

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-3. Analysis of Essential Hypertension (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,145		
Background RH	356	0.87 (0.66,1.14)	0.320
Low RH	217	0.87 (0.63,1.20)	0.395
High RH	235	1.27 (0.93,1.74)	0.131
Low plus High RH	452	1.06 (0.84,1.35)	0.624

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	282	96 (34.0)	1.22 (1.11,1.34)	<0.001
Medium	276	105 (38.0)		
High	285	140 (49.1)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
808	1.18 (1.04,1.34)	0.011

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.1.2   *Heart Disease (Excluding Essential Hypertension)*

The unadjusted and adjusted Model 1 analyses of a history of heart disease each showed significant group differences when combining all occupations (Table 14-4(a,b): Est. RR=1.26, p=0.013; Adj. RR=1.26, p=0.018, respectively). The percentage of Ranch Hands with heart disease was 66.1 versus 60.8 percent for Comparisons. Stratifying by occupation, unadjusted and adjusted analyses revealed group differences within the enlisted flyer stratum (Table 14-4(a,b): Est. RR=2.10, p=0.003; Adj. RR=2.05; p=0.004, respectively). The percentage of Ranch Hand enlisted flyers with heart disease was 75.2 versus 59.7 percent for the Comparison enlisted flyers.

Table 14-4. Analysis of Heart Disease (Excluding Essential Hypertension)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*568 (66.1)*	*1.26 (1.05,1.51)*	*0.013*
	Comparison	*1,232*	*749 (60.8)*		
Officer	Ranch Hand	334	238 (71.3)	1.22 (0.90,1.66)	0.191
	Comparison	484	324 (66.9)		
Enlisted Flyer	Ranch Hand	149	112 (75.2)	2.10 (1.27,3.28)	0.003
	Comparison	186	111 (59.7)		
Enlisted Groundcrew	Ranch Hand	376	218 (58.0)	1.10 (0.84,1.42)	0.523
	Comparison	562	314 (55.9)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.26 (1.04,1.53)*	*0.018*
Officer	1.21 (0.88,1.66)	0.238
Enlisted Flyer	2.10 (1.28,3.45)	0.004
Enlisted Groundcrew	1.10 (0.83,1.46)	0.496

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	115 (74.2)	0.79 (0.68,0.91)	0.001
Medium	161	99 (61.5)		
High	160	88 (55.0)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	0.90 (0.75,1.08)	0.249

[a] Relative risk for a twofold increase in initial dioxin.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[a][b]	p-Value
Comparison	1,195	730 (61.1)		
Background RH	376	259 (68.9)	1.43 (1.11,1.83)	0.005
Low RH	233	163 (70.0)	1.48 (1.09,2.00)	0.011
High RH	243	139 (57.2)	0.84 (0.64,1.11)	0.228
Low plus High RH	476	302 (63.4)	1.11 (0.89,1.39)	0.359

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
  Comparison: 1987 Dioxin $\leq$ 10 ppt.
  Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
  Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
  High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	1.34 (1.03,1.75)	0.032
Low RH	221	1.33 (0.96,1.84)	0.081
High RH	236	1.03 (0.76,1.40)	0.865
Low plus High RH	457	1.16 (0.92,1.48)	0.209

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
  Comparison: 1987 Dioxin $\leq$ 10 ppt.
  Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
  Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
  High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	192 (67.6)	0.87 (0.79,0.96)	0.004
Medium	281	199 (70.8)		
High	287	170 (59.2)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = $\leq$7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
817	0.92 (0.81,1.04)	0.159

[a] Relative risk for a twofold increase in 1987 dioxin.

The unadjusted Model 2 analysis revealed a significant inverse association between heart disease and initial dioxin (Table 14-4(c): Est. RR=0.79, p=0.001). The percentages of participants with heart disease in the low, medium, and high initial dioxin categories were 74.2, 61.5, and 55.0, respectively. After covariate adjustment, the results became nonsignificant (Table 14-4(d): p=0.249).

The Model 3 unadjusted analysis of heart disease revealed two significant contrasts: Ranch Hands in the background dioxin category versus Comparisons and Ranch Hands in the low dioxin category versus Comparisons (Table 14-4(e): Est. RR=1.43, p=0.005; Est. RR=1.48, p=0.011, respectively). The adjusted analysis showed a significant difference between Ranch Hands in the background dioxin category and Comparisons (Table 14-4(f): Adj. RR=1.34, p=0.032) and a marginally significant difference between Ranch Hands in the low dioxin category and Comparisons (Table 14-4(f): Adj. RR=1.33, p=0.081). The percentages of participants with heart disease for Ranch Hands in the background dioxin category, Ranch Hands in the low dioxin category, and Comparisons were 68.9, 70.0, and 61.1, respectively.

The Model 4 unadjusted analysis showed a significant inverse association between heart disease and 1987 dioxin (Table 14-4(g): Est. RR=0.87, p=0.004). The percentages of participants with heart disease in the low, medium, and high 1987 dioxin categories were 67.6, 70.8, and 59.2, respectively. The results became nonsignificant after adjusting for covariates (Table 14-4(h): p=0.159).

14.2.2.1.3   Myocardial Infarction

All unadjusted and adjusted Model 1 through Model 4 analyses of myocardial infarction were nonsignificant (Table 14-5(a–h): p>0.10 for each analysis).

Table 14-5. Analysis of Myocardial Infarction

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*74 (8.6)*	*1.04 (0.76,1.43)*	*0.786*
	Comparison	*1,232*	*102 (8.3)*		
Officer	Ranch Hand	334	28 (8.4)	0.96 (0.58,1.59)	0.882
	Comparison	484	42 (8.7)		
Enlisted Flyer	Ranch Hand	149	16 (10.7)	1.37 (0.65,2.87)	0.403
	Comparison	186	15 (8.1)		
Enlisted Groundcrew	Ranch Hand	376	30 (8.0)	1.00 (0.62,1.61)	0.987
	Comparison	562	45 (8.0)		

Table 14-5. Analysis of Myocardial Infarction (Continued)

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.02 (0.73,1.42)*	*0.915*
Officer	0.86 (0.50,1.46)	0.567
Enlisted Flyer	1.57 (0.72,3.43)	0.255
Enlisted Groundcrew	0.99 (0.59,1.67)	0.975

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	12 (7.7)	1.01 (0.79,1.28)	0.945
Medium	161	18 (11.2)		
High	160	13 (8.1)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.30 (0.95,1.77)	0.106

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race because of the sparse number of participants with a myocardial infarction.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	98 (8.2)		
Background RH	376	29 (7.7)	0.98 (0.63,1.51)	0.919
Low RH	233	19 (8.2)	0.99 (0.59,1.65)	0.958
High RH	243	24 (9.9)	1.18 (0.73,1.89)	0.496
Low plus High RH	476	43 (9.0)	1.08 (0.74,1.58)	0.689

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
       Comparison: 1987 Dioxin ≤ 10 ppt.
       Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
       Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
       High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-5. Analysis of Myocardial Infarction (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.89 (0.55,1.43)	0.625
Low RH	221	0.84 (0.49,1.46)	0.544
High RH	236	1.39 (0.83,2.32)	0.215
Low plus High RH	457	1.09 (0.73,1.63)	0.673

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	21 (7.4)	1.03 (0.87,1.21)	0.740
Medium	281	23 (8.2)		
High	287	28 (9.8)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	1.16 (0.94,1.44)	0.170

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.1.4   Stroke or Transient Ischemic Attack

All analysis results of stroke or transient ischemic attack were nonsignificant (Table 14-6(a–h): p≥ 0.10 for each analysis).

Table 14-6. Analysis of Stroke or Transient Ischemic Attack

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*11 (1.3)*	*1.13 (0.51,2.50)*	*0.766*
	Comparison	*1,232*	*14 (1.1)*		
Officer	Ranch Hand	334	5 (1.5)	1.46 (0.42,5.07)	0.555
	Comparison	484	5 (1.0)		
Enlisted Flyer	Ranch Hand	149	0 (0.0)	--	0.330[a]
	Comparison	186	3 (1.6)		
Enlisted Groundcrew	Ranch Hand	376	6 (1.6)	1.50 (0.48,4.69)	0.483
	Comparison	562	6 (1.1)		

[a] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with a stroke or transient ischemic attack.
--: Results not presented because of the sparse number of participants with a stroke or transient ischemic attack.

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.21 (0.51,2.85)*	*0.666*
Officer	1.18 (0.31,4.51)	0.806
Enlisted Flyer	--	--
Enlisted Groundcrew	1.80 (0.53,6.06)	0.345

--: Results not presented because of the sparse number of participants with a stroke or transient ischemic attack.

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log$_2$ (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	1 (0.6)	1.22 (0.68,2.16)	0.513
Medium	161	2 (1.2)		
High	160	3 (1.9)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-6. *Analysis of Stroke or Transient Ischemic Attack (Continued)*

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
457	1.33 (0.72,2.47)	0.379

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race and occupation because of the sparse number of Ranch Hands with a stroke or transient ischemic attack.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	14 (1.2)		
Background RH	376	5 (1.3)	1.13 (0.40,3.18)	0.816
Low RH	233	1 (0.4)	0.36 (0.05,2.78)	0.330
High RH	243	5 (2.1)	1.78 (0.63,5.02)	0.275
Low plus High RH	476	6 (1.3)	0.82 (0.25,2.68)	0.741

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
 Comparison: 1987 Dioxin ≤ 10 ppt.
 Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
 Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
 High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.97 (0.30,3.16)	0.956
Low RH	221	0.42 (0.05,3.26)	0.404
High RH	236	2.65 (0.83,8.46)	0.100
Low plus High RH	457	1.08 (0.32,3.71)	0.900

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
 Comparison: 1987 Dioxin ≤ 10 ppt.
 Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
 Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
 High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-6. Analysis of Stroke or Transient Ischemic Attack (Continued)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log₂ (1987 Dioxin + 1)	
1987 Dioxin	**n**	**Number (%) Yes**	**Estimated Relative Risk (95% C.I.)[a]**	**p-Value**
Low	284	4 (1.4)	0.99 (0.66,1.48)	0.957
Medium	281	2 (0.7)		
High	287	5 (1.7)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log₂ (1987 Dioxin + 1)		
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
817	1.15 (0.71,1.85)	0.578

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for occupation because of the sparse number of Ranch Hands with a stroke or transient ischemic attack.

14.2.2.2 Physical Examination Variables – Central Cardiac Function

14.2.2.2.1   Systolic Blood Pressure (Continuous)

All Model 1 and Model 2 analyses of systolic blood pressure in its continuous form showed no significant results (Table 14-7(a–d): p>0.23 for each analysis).

Table 14-7. Analysis of Systolic Blood Pressure (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	*Ranch Hand*	*859*	*124.9*	*–0.7 --*	*0.383*
	Comparison	*1,232*	*125.6*		
Officer	Ranch Hand	334	125.9	–0.2 --	0.865
	Comparison	484	126.2		
Enlisted Flyer	Ranch Hand	149	127.0	–0.3 --	0.875
	Comparison	186	127.3		
Enlisted Groundcrew	Ranch Hand	376	123.1	–1.4 --	0.241
	Comparison	562	124.5		

[a] Transformed from natural logarithm scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[c] P-value is based on difference of means on natural logarithm scale.

Table 14-7. Analysis of Systolic Blood Pressure (Continuous) (Continued)

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Group	n	Adjusted Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	*Ranch Hand*	*822*	*127.7*	*−0.6 --*	*0.415*
	Comparison	*1,189*	*128.4*		
Officer	Ranch Hand	322	127.2	−0.9 --	0.468
	Comparison	472	128.1		
Enlisted Flyer	Ranch Hand	140	128.7	0.1 --	0.967
	Comparison	178	128.6		
Enlisted Groundcrew	Ranch Hand	360	127.5	−0.7 --	0.574
	Comparison	539	128.2		

[a] Transformed from natural logarithm scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[c] P-value is based on difference of means on natural logarithm scale.

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	n	Mean[a]	Adj. Mean[ab]	R^2	Slope (Std. Error)[c]	p-Value
Low	155	125.8	126.4	0.049	−0.006 (0.005)	0.238
Medium	161	125.7	125.8			
High	160	124.2	123.6			

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Slope and standard error based on natural logarithm of systolic blood pressure versus log_2 (initial dioxin).

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	n	Adj. Mean[a]	R^2	Adj. Slope (Std. Error)[b]	p-Value
Low	150	129.0	0.135	−0.000 (0.006)	0.983
Medium	150	130.2			
High	157	128.5			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of systolic blood pressure versus log_2 (initial dioxin).

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-7. Analysis of Systolic Blood Pressure (Continuous) (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Mean[a]	Adj. Mean[ab]	Difference of Adj. Mean vs. Comparisons (95% C.I.)[c]	p-Value[d]
Comparison	1,195	125.6	125.5		
Background RH	376	124.4	125.4	−0.1 --	0.935
Low RH	233	126.2	125.9	0.4 --	0.730
High RH	243	124.4	123.4	−2.1 --	0.079
Low plus High RH	476	125.2	124.6	−0.9 --	0.346

[a] Transformed from natural logarithm scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[d] P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adj. Mean[a]	Difference of Adj. Mean vs. Comparisons (95% C.I.)[b]	p-Value[c]
Comparison	1,155	128.5		
Background RH	360	128.5	0.0 --	0.990
Low RH	221	127.9	−0.6 --	0.651
High RH	236	127.0	−1.5 --	0.222
Low plus High RH	457	127.4	−1.1 --	0.262

[a] Transformed from natural logarithm scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on natural logarithm scale.
[c] P-value is based on difference of means on natural logarithm scale.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-7. Analysis of Systolic Blood Pressure (Continuous) (Continued)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin +1)		
1987 Dioxin	n	Mean[a]	R^2	Slope (Std. Error)[b]	p-Value
Low	284	124.0	<0.001	0.001 (0.003)	0.693
Medium	281	125.9			
High	287	124.8			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of systolic blood pressure versus log_2 (1987 dioxin + 1).

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)		
1987 Dioxin	n	Adj. Mean[a]	R^2	Adjusted Slope (Std. Error)[b]	p-Value
Low	271	128.3	0.126	−0.005 (0.004)	0.165
Medium	271	127.2			
High	275	127.1			

[a] Transformed from natural logarithm scale.
[b] Slope and standard error based on natural logarithm of systolic blood pressure versus log_2 (1987 dioxin + 1).

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

The unadjusted Model 3 analysis showed a marginally significant difference between Ranch Hands in the high dioxin category and Comparisons (Table 14-7(e): difference of means=−2.1 mm Hg, p=0.079). Ranch Hands in the high dioxin category had a lower mean systolic blood pressure (123.4 mm Hg) than the Comparisons (125.5 mm Hg). The adjusted Model 3 analysis revealed no significant contrasts (Table 14-7(f): p>0.22 for each contrast).

Both the unadjusted and adjusted Model 4 analyses revealed no significant associations between 1987 dioxin and systolic blood pressure in its continuous form (Table 14-7(g,h): p>0.16 for each analysis).

14.2.2.2.2   *Systolic Blood Pressure (Discrete)*

The unadjusted and adjusted Model 1 analyses of systolic blood pressure in its discrete form showed no significant differences between Ranch Hands and Comparisons when examined across all occupations and within each occupation (Table 14-8(a,b): p>0.63 for each contrast).

Table 14-8. Analysis of Systolic Blood Pressure (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) High	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*181 (21.1)*	*0.99 (0.80,1.22)*	*0.914*
	Comparison	*1,232*	*262 (21.3)*		
Officer	Ranch Hand	334	78 (23.4)	1.01 (0.73,1.41)	0.944
	Comparison	484	112 (23.1)		
Enlisted Flyer	Ranch Hand	149	36 (24.2)	1.06 (0.64,1.76)	0.823
	Comparison	186	43 (23.1)		
Enlisted Groundcrew	Ranch Hand	376	67 (17.8)	0.92 (0.66,1.29)	0.638
	Comparison	562	107 (19.0)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.99 (0.79,1.24)*	*0.899*
Officer	0.95 (0.67,1.35)	0.784
Enlisted Flyer	1.13 (0.66,1.93)	0.661
Enlisted Groundcrew	0.96 (0.67,1.38)	0.832

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	40 (25.8)	0.83 (0.69,0.99)	0.031
Medium	161	36 (22.4)		
High	160	29 (18.1)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	0.89 (0.71,1.11)	0.296

[a] Relative risk for a twofold increase in initial dioxin.

Table 14-8. Analysis of Systolic Blood Pressure (Discrete) (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) High	Est. Relative Risk (95% C.I.)[a][b]	p-Value
Comparison	1,195	253 (21.2)		
Background RH	376	74 (19.7)	1.00 (0.75,1.34)	0.998
Low RH	233	59 (25.3)	1.25 (0.90,1.73)	0.188
High RH	243	46 (18.9)	0.80 (0.56,1.14)	0.208
Low plus High RH	476	105 (22.1)	0.99 (0.76,1.29)	0.952

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
 Comparison: 1987 Dioxin $\leq$ 10 ppt.
 Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
 Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
 High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	1.00 (0.73,1.37)	0.983
Low RH	221	1.12 (0.79,1.59)	0.532
High RH	236	0.84 (0.57,1.23)	0.365
Low plus High RH	457	0.96 (0.73,1.27)	0.791

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
 Comparison: 1987 Dioxin $\leq$ 10 ppt.
 Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
 Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
 High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) High	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	54 (19.0)	1.00 (0.89,1.12)	0.956
Medium	281	66 (23.5)		
High	287	59 (20.6)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = $\leq$7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

Table 14-8. Analysis of Systolic Blood Pressure (Discrete) (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
Analysis Results for Log$_2$ (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	0.88 (0.76,1.02)	0.099

[a] Relative risk for a twofold increase in 1987 dioxin.

A significant inverse association between discrete systolic blood pressure and initial dioxin was found in the unadjusted Model 2 analysis (Table 14-8(c): Est. RR=0.83, p=0.031). After adjusting for covariates, the results became nonsignificant (Table 14-8(d): p=0.296).

The unadjusted and adjusted Model 3 analyses of systolic blood pressure showed no significant contrasts between the Ranch Hand dioxin category and Comparisons (Table 14-8(e,f): p>0.18 for each contrast).

The unadjusted Model 4 results were nonsignificant (Table 14-8(g): p=0.956). After adjusting for covariates, the results became marginally significant (Table 14-8(h): Adj. RR=0.88, p=0.099). The percentages of participants with high discrete systolic blood pressures in the low, medium, and high 1987 dioxin categories were 19.0, 23.5, and 20.6, respectively.

14.2.2.2.3   *Diastolic Blood Pressure (Continuous)*

All Model 1 and Model 2 analyses of diastolic blood pressure in its continuous form showed no significant results (Table 14-9(a–d): p≥0.19 for each analysis).

The unadjusted Model 3 analysis of continuous diastolic blood pressure revealed a marginally significant difference between Ranch Hands in the high dioxin category and Comparisons (Table 14-9(e): difference of means=1.08 mm Hg, p=0.099). The adjusted results were nonsignificant (Table 14-9(f): p>0.13 for each contrast).

A significant positive association between 1987 dioxin and continuous diastolic blood pressure was found in the unadjusted Model 4 analysis (Table 14-9(g): slope=0.031, p=0.014). The mean diastolic blood pressure in the low, medium, and high 1987 dioxin categories was 73.97 mm Hg, 73.76 mm Hg, and 75.94 mm Hg, respectively. After adjusting for covariates, the results became nonsignificant (Table 14-9(h): p=0.315).

Table 14-9. Analysis of Diastolic Blood Pressure (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Mean[a]	Difference of Means (95% C.I.)[b]	p-Value[c]
All	*Ranch Hand*	*859*	*74.55*	*−0.06 --*	*0.883*
	Comparison	*1,232*	*74.61*		
Officer	Ranch Hand	334	74.17	−0.04 --	0.952
	Comparison	484	74.21		
Enlisted Flyer	Ranch Hand	149	75.22	0.12 --	0.905
	Comparison	186	75.10		
Enlisted Groundcrew	Ranch Hand	376	74.63	−0.17 --	0.780
	Comparison	562	74.80		

[a] Transformed from square root scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.
[c] P-value is based on difference of means on square root scale.

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Group	n	Adjusted Mean[a]	Difference of Adj. Means (95% C.I.)[b]	p-Value[c]
All	*Ranch Hand*	*822*	*75.68*	*0.06 --*	*0.889*
	Comparison	*1,189*	*75.62*		
Officer	Ranch Hand	322	75.29	−0.08 --	0.907
	Comparison	472	75.37		
Enlisted Flyer	Ranch Hand	140	76.47	0.33 --	0.752
	Comparison	178	76.13		
Enlisted Groundcrew	Ranch Hand	360	75.37	0.08 --	0.898
	Comparison	539	75.29		

[a] Transformed from square root scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.
[c] P-value is based on difference of means on square root scale.

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics				Analysis Results for Log_2 (Initial Dioxin)[b]		
Initial Dioxin	n	Mean[a]	Adj. Mean[ab]	R^2	Slope (Std. Error)[c]	p-Value
Low	155	74.07	74.24	0.023	0.025 (0.019)	0.190
Medium	161	75.16	75.17			
High	160	76.07	75.89			

[a] Transformed from square root scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Slope and standard error based on square root of diastolic blood pressure versus log_2 (initial dioxin).

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-9. Analysis of Diastolic Blood Pressure (Continuous) (Continued)

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)		
Initial Dioxin	n	Adj. Mean[a]	R^2	Adj. Slope (Std. Error)[b]	p-Value
Low	150	76.09	0.073	0.019 (0.023)	0.425
Medium	150	77.21			
High	157	77.40			

[a] Transformed from square root scale.
[b] Slope and standard error based on square root of diastolic blood pressure versus log_2 (initial dioxin).

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Mean[a]	Adj. Mean[ab]	Difference of Adj. Mean vs. Comparisons (95% C.I.)[c]	p-Value[d]
Comparison	1,195	74.58	74.57		
Background RH	376	73.87	74.14	−0.43 --	0.432
Low RH	233	74.26	74.19	−0.38 --	0.569
High RH	243	75.93	75.65	1.08 --	0.099
Low plus High RH	476	75.11	74.93	0.36 --	0.468

[a] Transformed from square root scale.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.
[d] P-value is based on difference of means on square root scale.

Note: RH = Ranch Hand.
        Comparison: 1987 Dioxin ≤ 10 ppt.
        Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
        Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
        High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-9. Analysis of Diastolic Blood Pressure (Continuous) (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adj. Mean[a]	Difference of Adj. Mean vs. Comparisons (95% C.I.)[b]	p-Value[c]
Comparison	1,155	75.67		
Background RH	360	75.56	−0.11 --	0.844
Low RH	221	75.23	−0.44 --	0.515
High RH	236	76.69	1.02 --	0.135
Low plus High RH	457	75.98	0.31 --	0.544

[a] Transformed from square root scale.
[b] Difference of means after transformation to original scale; confidence interval on difference of means not presented because analysis was performed on square root scale.
[c] P-value is based on difference of means on square root scale.

Note: RH = Ranch Hand.
    Comparison: 1987 Dioxin ≤ 10 ppt.
    Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
    Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
    High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for $\log_2$ (1987 Dioxin +1)		
1987 Dioxin	n	Mean[a]	R^2	Slope (Std. Error)[b]	p-Value
Low	284	73.97	0.007	0.031 (0.013)	0.014
Medium	281	73.76			
High	287	75.94			

[a] Transformed from square root scale.
[b] Slope and standard error based on square root of diastolic blood pressure versus $\log_2$ (1987 dioxin + 1).

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for $\log_2$ (1987 Dioxin + 1)		
1987 Dioxin	n	Adj. Mean[a]	R^2	Adjusted Slope (Std. Error)[b]	p-Value
Low	271	75.59	0.061	0.016 (0.016)	0.315
Medium	271	75.01			
High	275	77.24			

[a] Transformed from square root scale.
[b] Slope and standard error based on square root of diastolic blood pressure versus $\log_2$ (1987 dioxin + 1).

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

14.2.2.2.4   Diastolic Blood Pressure (Discrete)

All unadjusted and adjusted analyses of diastolic blood pressure in its dichotomous form were nonsignificant (Table 14-10(a–h): p>0.19 for each analysis).

Table 14-10. Analysis of Diastolic Blood Pressure (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) High	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*45 (5.2)*	*1.06 (0.71,1.58)*	*0.769*
	Comparison	*1,232*	*61 (5.0)*		
Officer	Ranch Hand	334	20 (6.0)	1.34 (0.72,2.49)	0.360
	Comparison	484	22 (4.5)		
Enlisted Flyer	Ranch Hand	149	8 (5.4)	1.26 (0.46,3.45)	0.649
	Comparison	186	8 (4.3)		
Enlisted Groundcrew	Ranch Hand	376	17 (4.5)	0.81 (0.44,1.49)	0.499
	Comparison	562	31 (5.5)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.02 (0.67,1.56)*	*0.916*
Officer	1.21 (0.62,2.35)	0.576
Enlisted Flyer	1.18 (0.41,3.37)	0.760
Enlisted Groundcrew	0.84 (0.44,1.59)	0.584

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) High	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	7 (4.5)	1.04 (0.79,1.37)	0.793
Medium	161	12 (7.5)		
High	160	10 (6.3)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.15 (0.80,1.67)	0.446

[a] Relative risk for a twofold increase in initial dioxin.

Table 14-10. Analysis of Diastolic Blood Pressure (Discrete) (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY − UNADJUSTED

Dioxin Category	n	Number (%) High	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	59 (4.9)		
Background RH	376	15 (4.0)	0.85 (0.47,1.52)	0.576
Low RH	233	12 (5.2)	1.04 (0.55,1.96)	0.915
High RH	243	17 (7.0)	1.37 (0.78,2.41)	0.267
Low plus High RH	476	29 (6.1)	1.20 (0.75,1.90)	0.447

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY − ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.78 (0.41,1.48)	0.449
Low RH	221	0.91 (0.45,1.83)	0.792
High RH	236	1.46 (0.80,2.68)	0.221
Low plus High RH	457	1.16 (0.71,1.91)	0.551

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS − 1987 DIOXIN − UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) High	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	14 (4.9)	1.14 (0.94,1.39)	0.198
Medium	281	9 (3.2)		
High	287	21 (7.3)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

Table 14-10. Analysis of Diastolic Blood Pressure (Discrete) (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
817	1.20 (0.89,1.61)	0.228

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.2.5   Heart Sounds

All Model 1 and Model 2 analyses of heart sounds were nonsignificant (Table 14-11(a–d): p>0.11 for each analysis).

Table 14-11. Analysis of Heart Sounds

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*31 (3.6)*	*0.71 (0.45,1.10)*	*0.116*
	Comparison	*1,232*	*62 (5.0)*		
Officer	Ranch Hand	334	11 (3.3)	0.60 (0.29,1.23)	0.164
	Comparison	484	26 (5.4)		
Enlisted Flyer	Ranch Hand	149	7 (4.7)	0.78 (0.30,2.08)	0.625
	Comparison	186	11 (5.9)		
Enlisted Groundcrew	Ranch Hand	376	13 (3.5)	0.77 (0.39,1.52)	0.452
	Comparison	562	25 (4.4)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.71 (0.45,1.13)*	*0.139*
Officer	0.60 (0.28,1.29)	0.190
Enlisted Flyer	0.65 (0.23,1.84)	0.419
Enlisted Groundcrew	0.86 (0.42,1.74)	0.675

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	6 (3.9)	1.01 (0.73,1.40)	0.958
Medium	161	10 (6.2)		
High	160	6 (3.8)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-11. Analysis of Heart Sounds (Continued)

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
457	1.28 (0.83,1.98)	0.266

[a] Relative risk for a twofold increase in initial dioxin.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	60 (5.0)		
Background RH	376	9 (2.4)	0.48 (0.24,0.99)	0.047
Low RH	233	10 (4.3)	0.84 (0.42,1.67)	0.622
High RH	243	12 (4.9)	0.94 (0.50,1.79)	0.857
Low plus High RH	476	22 (4.6)	0.89 (0.54,1.48)	0.656

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
      Comparison: 1987 Dioxin ≤ 10 ppt.
      Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
      Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
      High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.45 (0.21,0.97)	0.041
Low RH	221	0.80 (0.39,1.61)	0.528
High RH	236	1.05 (0.52,2.11)	0.901
Low plus High RH	457	0.92 (0.54,1.56)	0.750

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
      Comparison: 1987 Dioxin ≤ 10 ppt.
      Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
      Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
      High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-11. Analysis of Heart Sounds (Continued)

(g) MODEL 4: RANCH HANDS − 1987 DIOXIN − UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	8 (2.8)	1.16 (0.92,1.46)	0.220
Medium	281	9 (3.2)		
High	287	14 (4.9)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS − 1987 DIOXIN − ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	1.24 (0.89,1.73)	0.193

[a] Relative risk for a twofold increase in 1987 dioxin.

The unadjusted and adjusted Model 3 analyses each showed a significant difference between Ranch Hands in the background dioxin category and Comparisons (Table 14-11(e,f): Est. RR=0.48, p=0.047; Adj. RR=0.45, p=0.041, respectively). The percentage of participants with abnormal heart sounds was lower for Ranch Hands in the background dioxin category (2.4%) than for Comparisons (5.0%).

Model 4 unadjusted and adjusted analyses showed no significant association between heart sounds and 1987 dioxin (Table 14-11(g,h): p>0.19 for each analysis).

14.2.2.2.6   *Overall Electrocardiograph*

The unadjusted and adjusted Model 1 analyses of overall ECG showed no overall group difference between Ranch Hands and Comparisons (Table 14-12(a,b): p>0.68 for each contrast). Stratifying by occupation revealed a marginally significant group difference within the enlisted groundcrew stratum for both the unadjusted and adjusted analyses (Table 14-12(a,b): Est. RR=0.77, p=0.096; Adj. RR=0.76, p=0.095, respectively). The percentage of enlisted groundcrew with abnormal overall ECG results was lower for Ranch Hands (23.4%) than for Comparisons (28.3%).

Both the unadjusted and adjusted Model 2 analyses of overall ECG were nonsignificant (Table 14-12(c,d): p>0.17 for each analysis).

The unadjusted Model 3 analyses of overall ECG did not show any of the Ranch Hand categories to be significantly different from the Comparison group (Table 14-12(e): p>0.60 for each contrast). After adjusting for covariates, a marginally significant difference between Ranch Hands in the low dioxin category and Comparisons was revealed (Table 14-12(f): Adj. RR=0.73, p=0.063). The percentage of abnormal overall ECG results was lower for Ranch Hands (30.9%) than for Comparisons (31.2%). Both the unadjusted and adjusted Model 4 analyses were nonsignificant (Table 14-12(g,h): p>0.39 for each analysis).

Table 14-12. Analysis of Overall Electrocardiograph (ECG)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*268 (31.2)*	*1.00 (0.83,1.21)*	*0.988*
	Comparison	*1,232*	*384 (31.2)*		
Officer	Ranch Hand	334	120 (35.9)	1.10 (0.82,1.48)	0.506
	Comparison	484	163 (33.7)		
Enlisted Flyer	Ranch Hand	149	60 (40.3)	1.35 (0.86,2.11)	0.190
	Comparison	186	62 (33.3)		
Enlisted Groundcrew	Ranch Hand	376	88 (23.4)	0.77 (0.57,1.05)	0.096
	Comparison	562	159 (28.3)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.96 (0.78,1.18)*	*0.688*
Officer	1.07 (0.79,1.47)	0.655
Enlisted Flyer	1.24 (0.76,2.00)	0.389
Enlisted Groundcrew	0.76 (0.55,1.05)	0.095

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	51 (32.9)	0.90 (0.77,1.05)	0.171
Medium	161	47 (29.2)		
High	160	48 (30.0)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.14 (0.93,1.39)	0.200

[a] Relative risk for a twofold increase in initial dioxin.

Table 14-12. Analysis of Overall Electrocardiograph (ECG) (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	373 (31.2)		
Background RH	376	118 (31.4)	1.06 (0.82,1.36)	0.659
Low RH	233	72 (30.9)	0.98 (0.72,1.33)	0.883
High RH	243	74 (30.5)	0.92 (0.68,1.25)	0.602
Low plus High RH	476	146 (30.7)	0.95 (0.75,1.20)	0.659

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	1.00 (0.76,1.32)	0.980
Low RH	221	0.73 (0.52,1.02)	0.063
High RH	236	1.10 (0.78,1.54)	0.578
Low plus High RH	457	0.90 (0.70,1.16)	0.423

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	84 (29.6)	0.96 (0.87,1.06)	0.391
Medium	281	93 (33.1)		
High	287	87 (30.3)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

Table 14-12. Analysis of Overall Electrocardiograph (ECG) (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

	Analysis Results for Log_2 (1987 Dioxin + 1)	
	Adjusted Relative Risk	
n	**(95% C.I.)[a]**	**p-Value**
817	1.02 (0.89,1.17)	0.753

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.2.7   Right Bundle Branch Block

All unadjusted and adjusted analysis results of right bundle branch block were nonsignificant (Table 14-13(a–h): p>0.27 for each analysis).

Table 14-13. Analysis of Right Bundle Branch Block

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*21 (2.4)*	*0.91 (0.52,1.58)*	*0.739*
	Comparison	*1,232*	*33 (2.7)*		
Officer	Ranch Hand	334	8 (2.4)	0.89 (0.36,2.17)	0.796
	Comparison	484	13 (2.7)		
Enlisted Flyer	Ranch Hand	149	8 (5.4)	1.45 (0.51,4.10)	0.482
	Comparison	186	7 (3.8)		
Enlisted Groundcrew	Ranch Hand	376	5 (1.3)	0.57 (0.20,1.61)	0.288
	Comparison	562	13 (2.3)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.88 (0.49,1.56)*	*0.650*
Officer	0.89 (0.36,2.22)	0.807
Enlisted Flyer	1.47 (0.49,4.44)	0.493
Enlisted Groundcrew	0.55 (0.19,1.59)	0.271

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	**n**	**Number (%) Yes**	**Estimated Relative Risk (95% C.I.)[b]**	**p-Value**
Low	155	5 (3.2)	0.93 (0.59,1.46)	0.747
Medium	161	4 (2.5)		
High	160	3 (1.9)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-13. Analysis of Right Bundle Branch Block (Continued)

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
462	1.12 (0.62,2.04)	0.707

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race and family history of heart disease before age 45 because of the sparse number of Ranch Hands with a right bundle branch block.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	31 (2.6)		
Background RH	376	9 (2.4)	0.93 (0.44,1.98)	0.852
Low RH	233	5 (2.1)	0.82 (0.32,2.14)	0.688
High RH	243	7 (2.9)	1.10 (0.48,2.54)	0.818
Low plus High RH	476	12 (2.5)	0.96 (0.48,1.89)	0.895

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	1.04 (0.47,2.29)	0.920
Low RH	221	0.55 (0.19,1.60)	0.273
High RH	236	1.19 (0.49,2.88)	0.704
Low plus High RH	457	0.82 (0.39,1.71)	0.594

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-13.   Analysis of Right Bundle Branch Block (Continued)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	6 (2.1)	1.03 (0.77,1.38)	0.845
Medium	281	8 (2.8)		
High	287	7 (2.4)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	1.02 (0.69,1.50)	0.922

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with a right bundle branch block.

14.2.2.2.8   *Left Bundle Branch Block*

The unadjusted and adjusted Model 1 analyses of left bundle branch block were nonsignificant (Table 14-14(a,b): p≥0.15 for each contrast).

Table 14-14. Analysis of Left Bundle Branch Block

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*5 (0.6)*	*0.60 (0.21,1.70)*	*0.317*
	Comparison	*1,232*	*12 (1.0)*		
Officer	Ranch Hand	334	2 (0.6)	0.48 (0.10,2.39)	0.370
	Comparison	484	6 (1.2)		
Enlisted Flyer	Ranch Hand	149	1 (0.7)	--	0.911[a]
	Comparison	186	0 (0.0)		
Enlisted Groundcrew	Ranch Hand	376	2 (0.5)	0.50 (0.10,2.47)	0.391
	Comparison	562	6 (1.1)		

[a] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with a left bundle branch block.
--: Results not presented because of the sparse number of participants with a left bundle branch block.

Table 14-14. Analysis of Left Bundle Branch Block (Continued)

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.47 (0.15,1.50)*	*0.182*
Officer	0.21 (0.02,1.76)	0.150
Enlisted Flyer	--	--
Enlisted Groundcrew	0.56 (0.11,2.83)	0.479

--: Results not presented because of the sparse number of participants with a left bundle branch block.

Note: Results are not adjusted for race because of the sparse number of participants with a left bundle branch block.

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	1 (0.6)	0.21 (0.01,6.22)	0.213
Medium	161	0 (0.0)		
High	160	0 (0.0)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

Analysis Results for Log_2 (Initial Dioxin)		
n	Adjusted Relative Risk (95% C.I.)	p-Value
--	--	--

--: Results not presented because of the sparse number of Ranch Hands with a left bundle branch block.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	12 (1.0)		
Background RH	376	4 (1.1)	1.17 (0.37,3.68)	0.792
Low RH	233	1 (0.4)	0.42 (0.05,3.23)	0.403
High RH	243	0 (0.0)	--	0.237[c]
Low plus High RH	476	1 (0.2)	--	0.174[c]

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with left bundle branch block.
--: Results not presented because of the sparse number of participants with a left bundle branch block.

Note: RH = Ranch Hand.
      Comparison: 1987 Dioxin ≤ 10 ppt.
      Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
      Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
      High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-14. Analysis of Left Bundle Branch Block (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.87 (0.23,3.33)	0.838
Low RH	221	0.37 (0.05,2.91)	0.341
High RH	236	--	--
Low plus High RH	457	--	--

[a] Relative risk and confidence interval relative to Comparisons.
--: Results not presented because of the sparse number of participants with a left bundle branch block.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

   Results are not adjusted for race because of the sparse number of participants with a left bundle branch block.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	1 (0.4)	0.69 (0.35,1.36)	0.271
Medium	281	4 (1.4)		
High	287	0 (0.0)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
823	0.56 (0.23,1.39)	0.199

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for race and diabetic class because of the sparse number of participants with a left bundle branch block.

The unadjusted Model 2 analysis showed no significant association between left bundle branch block and initial dioxin (Table 14-14(c): p=0.213). Because of a sparse number of Ranch Hands with a left bundle branch block, the adjusted Model 2 analysis was not performed.

All unadjusted and adjusted Model 3 and 4 analyses were nonsignificant (Table 14-14(e–h): p>0.17 for each analysis).

All unadjusted and adjusted analyses of non-specific ST- and T-wave changes were nonsignificant (Table 14-15(a–h): $p \geq 0.18$ for each analysis).

Table 14-15. Analysis of Non-Specific ST- and T-Wave Changes

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*160 (18.6)*	*1.04 (0.83,1.30)*	*0.724*
	Comparison	*1,232*	*222 (18.0)*		
Officer	Ranch Hand	334	70 (21.0)	1.09 (0.77,1.53)	0.641
	Comparison	484	95 (19.6)		
Enlisted Flyer	Ranch Hand	149	33 (22.1)	1.27 (0.74,2.17)	0.380
	Comparison	186	34 (18.3)		
Enlisted Groundcrew	Ranch Hand	376	57 (15.2)	0.90 (0.63,1.29)	0.570
	Comparison	562	93 (16.5)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.00 (0.79,1.27)*	*0.984*
Officer	1.03 (0.71,1.48)	0.882
Enlisted Flyer	1.22 (0.69,2.14)	0.495
Enlisted Groundcrew	0.88 (0.60,1.29)	0.517

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	32 (20.6)	0.91 (0.76,1.08)	0.280
Medium	161	34 (21.1)		
High	160	31 (19.4)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.15 (0.91,1.44)	0.237

[a] Relative risk for a twofold increase in initial dioxin.

Table 14-15. Analysis of Non-Specific ST- and T-Wave Changes (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[a][b]	p-Value
Comparison	1,195	218 (18.2)		
Background RH	376	59 (15.7)	0.91 (0.66,1.25)	0.545
Low RH	233	47 (20.2)	1.12 (0.78,1.59)	0.537
High RH	243	50 (20.6)	1.08 (0.76,1.52)	0.677
Low plus High RH	476	97 (20.4)	1.10 (0.84,1.44)	0.502

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
      Comparison: 1987 Dioxin $\leq$ 10 ppt.
      Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
      Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
      High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.82 (0.58,1.15)	0.242
Low RH	221	0.91 (0.62,1.32)	0.614
High RH	236	1.26 (0.86,1.84)	0.238
Low plus High RH	457	1.07 (0.80,1.43)	0.628

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
      Comparison: 1987 Dioxin $\leq$ 10 ppt.
      Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
      Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
      High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	43 (15.1)	1.06 (0.94,1.19)	0.361
Medium	281	52 (18.5)		
High	287	61 (21.3)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = $\leq$7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

Table 14-15. *Analysis of Non-Specific ST- and T-Wave Changes (Continued)*

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
Analysis Results for Log$_2$ (1987 Dioxin + 1)		
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
817	1.12 (0.95,1.32)	0.180

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.2.10   *Bradycardia*

The Model 1 and 2 analyses of bradycardia did not show a significant association with dioxin in either the unadjusted or adjusted analysis (Table 14-16(a–d): p≥0.12 for each analysis).

Table 14-16. Analysis of Bradycardia

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	**Group**	**n**	**Number (%) Yes**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	*Ranch Hand*	*859*	*24 (2.8)*	*0.69 (0.42,1.14)*	*0.142*
	Comparison	*1,232*	*49 (4.0)*		
Officer	Ranch Hand	334	15 (4.5)	0.69 (0.36,1.29)	0.245
	Comparison	484	31 (6.4)		
Enlisted Flyer	Ranch Hand	149	5 (3.4)	1.26 (0.36,4.43)	0.722
	Comparison	186	5 (2.7)		
Enlisted Groundcrew	Ranch Hand	376	4 (1.1)	0.45 (0.15,1.40)	0.170
	Comparison	562	13 (2.3)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED		
Occupational Category	**Adjusted Relative Risk (95% C.I.)**	**p-Value**
All	*0.69 (0.41,1.16)*	*0.151*
Officer	0.74 (0.38,1.42)	0.360
Enlisted Flyer	1.14 (0.32,4.09)	0.846
Enlisted Groundcrew	0.36 (0.10,1.30)	0.120

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED				
Initial Dioxin Category Summary Statistics			**Analysis Results for Log$_2$ (Initial Dioxin)[a]**	
Initial Dioxin	**n**	**Number (%) Yes**	**Estimated Relative Risk (95% C.I.)[b]**	**p-Value**
Low	155	4 (2.6)	0.86 (0.44,1.65)	0.631
Medium	161	2 (1.2)		
High	160	1 (0.6)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-16. Analysis of Bradycardia (Continued)

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
466	0.98 (0.44,2.22)	0.971

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race, diabetic class, and family history of heart disease before age 45 because of the sparse number of Ranch Hands with bradycardia.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	47 (3.9)		
Background RH	376	16 (4.3)	0.95 (0.53,1.71)	0.867
Low RH	233	5 (2.1)	0.55 (0.21,1.39)	0.204
High RH	243	2 (0.8)	0.23 (0.05,0.95)	0.042
Low plus High RH	476	7 (1.5)	0.35 (0.14,0.85)	0.020

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.81 (0.44,1.49)	0.497
Low RH	221	0.49 (0.17,1.40)	0.183
High RH	236	0.35 (0.08,1.50)	0.156
Low plus High RH	457	0.41 (0.16,1.05)	0.062

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-16. Analysis of Bradycardia (Continued)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	11 (3.9)	0.77 (0.56,1.05)	0.084
Medium	281	9 (3.2)		
High	287	3 (1.0)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
828	0.98 (0.65,1.49)	0.932

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for family history of heart disease before age 45 because of the sparse number of Ranch Hands with bradycardia.

The unadjusted Model 3 analysis of bradycardia revealed two significant contrasts: Ranch Hands in the high dioxin category versus Comparisons and Ranch Hands in the low plus high dioxin category versus Comparisons (Table 14-16(e): Est. RR=0.23, p=0.042; Est. RR=0.35, p=0.020, respectively). The percentage of participants with bradycardia was higher for Comparisons (3.9%) than for Ranch Hands in the high dioxin category (0.8%) or Ranch Hands in the low plus high dioxin category (1.5%). After covariate adjustment, there was a marginally significant difference between Ranch Hands in the low plus high dioxin category and Comparisons (Table 14-16(f): Adj. RR=0.41, p=0.062).

The unadjusted Model 4 analysis of bradycardia revealed a marginally significant inverse association between bradycardia and 1987 dioxin (Table 14-16(g): Est. RR=0.77, p=0.084). The percentages of participants with bradycardia in the low, medium, and high 1987 dioxin categories were 3.9, 3.2, and 1.0, respectively. After covariate adjustment, the results became nonsignificant (Table 14-16(h): p=0.932).

14.2.2.2.11 Tachycardia

The unadjusted and adjusted Model 1 analyses of tachycardia were nonsignificant (Table 14-17(a,b): p>0.12 for each contrast).

Table 14-17. Analysis of Tachycardia

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*6 (0.7)*	*2.16 (0.61,7.68)*	*0.228*
	Comparison	*1,232*	*4 (0.3)*		
Officer	Ranch Hand	334	1 (0.3)	1.45 (0.09,23.27)	0.793
	Comparison	484	1 (0.2)		
Enlisted Flyer	Ranch Hand	149	3 (2.0)	--	0.174[a]
	Comparison	186	0 (0.0)		
Enlisted Groundcrew	Ranch Hand	376	2 (0.5)	1.00 (0.17,5.99)	0.997
	Comparison	562	3 (0.5)		

[a] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with tachycardia.

--: Results not presented because of the sparse number of participants with tachycardia.

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*2.94 (0.69,12.51)*	*0.129*
Officer	--	--
Enlisted Flyer	--	--
Enlisted Groundcrew	1.54 (0.19,12.63)	0.685

--: Results not presented because of the sparse number of participants with tachycardia.

Note: Results are not adjusted for family history of heart disease because of the sparse number of participants with tachycardia.

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	0 (0.0)	1.38 (0.72,2.68)	0.340
Medium	161	1 (0.6)		
High	160	3 (1.9)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-17. Analysis of Tachycardia (Continued)

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	**Adjusted Relative Risk (95% C.I.)**	**p-Value**
--	--	--

--: Results not presented because of the sparse number of Ranch Hands with tachycardia.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	3 (0.3)		
Background RH	376	1 (0.3)	1.33 (0.14,13.00)	0.806
Low RH	233	0 (0.0)	--	0.999[c]
High RH	243	4 (1.6)	5.30 (1.15,24.53)	0.033
Low plus High RH	476	4 (0.8)	--	0.206[c]

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with tachycardia.
--: Results not presented because of the sparse number of participants with tachycardia.

Note: RH = Ranch Hand.
    Comparison: 1987 Dioxin ≤ 10 ppt.
    Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
    Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
    High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	2.01 (0.16,24.61)	0.585
Low RH	221	--	--
High RH	236	8.10 (1.19,55.01)	0.032
Low plus High RH	457	--	--

[a] Relative risk and confidence interval relative to Comparisons.
--: Results not presented because of the sparse number of participants with tachycardia.

Note: RH = Ranch Hand.
    Comparison: 1987 Dioxin ≤ 10 ppt.
    Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
    Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
    High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

    Results are not adjusted for family history of heart disease because of the sparse number of participants with tachycardia.

Table 14-17. Analysis of Tachycardia (Continued)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	1 (0.4)	1.56 (0.92,2.63)	0.111
Medium	281	0 (0.0)		
High	287	4 (1.4)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
825	1.55 (0.85,2.84)	0.165

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for occupation, current alcohol use, personality type, family history of heart disease, and diabetic class because of the sparse number of participants with tachycardia.

The unadjusted Model 2 analysis showed no significant association between tachycardia and initial dioxin (Table 14-17(c): p=0.340). Because of a sparse number of Ranch Hands with tachycardia, the adjusted Model 2 analysis was not performed.

The unadjusted and adjusted Model 3 analyses each showed a significant difference between Ranch Hands in the high dioxin category and Comparisons (Table 14-17(e,f): Est. RR=5.30, p=0.033; Adj. RR=8.10, p=0.032, respectively). The percentage of participants with tachycardia for Ranch Hands in the high dioxin categories was 1.6 versus 0.3 percent for Comparisons.

The unadjusted and adjusted Model 4 analyses were nonsignificant (Table 14-17(g,h): p>0.11 for each analysis).

14.2.2.2.12   Arrhythmia

All unadjusted and adjusted analyses of arrhythmia were nonsignificant (Table 14-18(a–h): p>0.11 for each analysis).

Table 14-18. Analysis of Arrhythmia

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*51 (5.9)*	*1.08 (0.74,1.57)*	*0.686*
	Comparison	*1,232*	*68 (5.5)*		
Officer	Ranch Hand	334	25 (7.5)	1.49 (0.84,2.63)	0.176
	Comparison	484	25 (5.2)		
Enlisted Flyer	Ranch Hand	149	13 (8.7)	1.39 (0.61,3.13)	0.433
	Comparison	186	12 (6.5)		
Enlisted Groundcrew	Ranch Hand	376	13 (3.5)	0.61 (0.32,1.19)	0.147
	Comparison	562	31 (5.5)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.02 (0.69,1.52)*	*0.913*
Officer	1.39 (0.75,2.55)	0.296
Enlisted Flyer	1.26 (0.54,2.97)	0.591
Enlisted Groundcrew	0.62 (0.31,1.25)	0.180

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	13 (8.4)	0.81 (0.60,1.10)	0.158
Medium	161	11 (6.8)		
High	160	8 (5.0)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.00 (0.68,1.48)	0.981

[a] Relative risk for a twofold increase in initial dioxin.

Table 14-18. Analysis of Arrhythmia (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[a][b]	p-Value
Comparison	1,195	65 (5.4)		
Background RH	376	18 (4.8)	0.90 (0.53,1.54)	0.703
Low RH	233	19 (8.2)	1.54 (0.90,2.61)	0.114
High RH	243	13 (5.3)	0.96 (0.52,1.77)	0.886
Low plus High RH	476	32 (6.7)	1.21 (0.77,1.88)	0.409

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.87 (0.49,1.57)	0.647
Low RH	221	1.17 (0.65,2.11)	0.596
High RH	236	1.10 (0.57,2.12)	0.774
Low plus High RH	457	1.13 (0.70,1.83)	0.604

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	14 (4.9)	0.99 (0.82,1.20)	0.932
Medium	281	20 (7.1)		
High	287	16 (5.6)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

Table 14-18. Analysis of Arrhythmia (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
Analysis Results for Log_2 (1987 Dioxin + 1)		
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
817	1.12 (0.85,1.49)	0.422

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.2.13   Evidence of Prior Myocardial Infarction

The Model 1 unadjusted and adjusted analyses of prior myocardial infarction from the ECG showed no significant group differences over all participants or within each occupational stratum (Table 14-19(a,b): p>0.64 for each contrast).

Table 14-19. Analysis of Evidence of Prior Myocardial Infarction

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	**Group**	**n**	**Number (%) Yes**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	*Ranch Hand*	*859*	*34 (4.0)*	*0.92 (0.59,1.42)*	*0.698*
	Comparison	*1,232*	*53 (4.3)*		
Officer	Ranch Hand	334	15 (4.5)	0.94 (0.48,1.83)	0.862
	Comparison	484	23 (4.8)		
Enlisted Flyer	Ranch Hand	149	7 (4.7)	0.97 (0.35,2.67)	0.952
	Comparison	186	9 (4.8)		
Enlisted Groundcrew	Ranch Hand	376	12 (3.2)	0.85 (0.41,1.75)	0.657
	Comparison	562	21 (3.7)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED		
Occupational Category	**Adjusted Relative Risk (95% C.I.)**	**p-Value**
All	*0.90 (0.56,1.43)*	*0.649*
Officer	0.88 (0.43,1.78)	0.718
Enlisted Flyer	1.02 (0.35,2.96)	0.972
Enlisted Groundcrew	0.86 (0.40,1.85)	0.709

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	5 (3.2)	1.05 (0.75,1.46)	0.793
Medium	161	9 (5.6)		
High	160	7 (4.4)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.84 (1.13,2.99)	0.012

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with evidence of a prior myocardial infarction.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	53 (4.4)		
Background RH	376	12 (3.2)	0.75 (0.39,1.42)	0.374
Low RH	233	11 (4.7)	1.06 (0.54,2.06)	0.867
High RH	243	10 (4.1)	0.88 (0.44,1.76)	0.722
Low plus High RH	476	21 (4.4)	0.96 (0.57,1.62)	0.891

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.69 (0.34,1.37)	0.285
Low RH	221	0.79 (0.39,1.61)	0.524
High RH	236	1.11 (0.52,2.36)	0.783
Low plus High RH	457	0.94 (0.54,1.65)	0.841

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
　　　Comparison: 1987 Dioxin ≤ 10 ppt.
　　　Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
　　　Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
　　　High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	7 (2.5)	1.09 (0.87,1.38)	0.447
Medium	281	12 (4.3)		
High	287	14 (4.9)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	1.33 (0.95,1.87)	0.089

[a] Relative risk for a twofold increase in 1987 dioxin.

The unadjusted Model 2 analysis revealed no significant association between initial dioxin and prior myocardial infarction (Table 14-19(c): p=0.793). After adjusting for covariates, the results became significant (Table 14-19(d): Adj. RR=1.84, p=0.012). The percentages of participants with evidence of prior myocardial infarction in the low, medium, and high initial dioxin categories were 3.2, 5.6, and 4.4, respectively.

The unadjusted and adjusted Model 3 analyses of prior myocardial infarction did not show any of the Ranch Hand categories to be significantly different from the Comparisons (Table 14-19(e,f): p>0.28 for each contrast).

The unadjusted Model 4 analysis revealed no significant association between 1987 dioxin and evidence of prior myocardial infarction (Table 14-19(g): p=0.447). After adjusting for covariates, the results became marginally significant (Table 14-19(h): Adj. RR=1.33, p=0.089). The percentages of participants with evidence of prior myocardial infarction in the low, medium, and high 1987 dioxin categories were 2.5, 4.3, and 4.9, respectively.

14.2.2.2.14 ECG: Other Diagnoses

The Model 1 unadjusted and adjusted analyses of other ECG diagnoses showed no significant group differences over all participants or within each occupational stratum (Table 14-20(a,b): p>0.15 for each contrast).

Table 14-20. Analysis of ECG: Other Diagnoses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Yes	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*3 (0.3)*	*4.31 (0.45,41.55)*	*0.168*
	Comparison	*1,232*	*1 (0.1)*		
Officer	Ranch Hand	334	1 (0.3)	--	0.852[a]
	Comparison	484	0 (0.0)		
Enlisted Flyer	Ranch Hand	149	0 (0.0)	--	--
	Comparison	186	0 (0.0)		
Enlisted Groundcrew	Ranch Hand	376	2 (0.5)	3.00 (0.27,33.20)	0.370
	Comparison	562	1 (0.2)		

[a] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with other abnormal ECG diagnoses.

--: Results not presented because of the sparse number of participants with other abnormal ECG diagnoses.

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*4.67 (0.47,46.79)*	*0.153*
Officer	--	--
Enlisted Flyer	--	--
Enlisted Groundcrew	3.29 (0.28,38.94)	0.346

--: Results not presented because of the sparse number of participants with other abnormal ECG diagnoses.

Note: Results are not adjusted for family history of heart disease before age 45 and diabetic class because of the sparse number of participants with other abnormal ECG diagnoses. Results for all occupations combined also are not adjusted for occupation because of the sparse number of participants with other abnormal ECG diagnoses.

Table 14-20. Analysis of ECG: Other Diagnoses (Continued)

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	0 (0.0)	1.53 (0.62,3.79)	0.381
Medium	161	0 (0.0)		
High	160	2 (1.3)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

Analysis Results for Log_2 (Initial Dioxin)		
n	Adjusted Relative Risk (95% C.I.)	p-Value
--	--	--

--: Results not presented because of the sparse number of Ranch Hands with other abnormal ECG diagnoses.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Yes	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	1 (0.1)		
Background RH	376	1 (0.3)	2.59 (0.16,41.85)	0.503
Low RH	233	0 (0.0)	--	0.999[c]
High RH	243	2 (0.8)	12.49 (1.10,142.56)	0.042
Low plus High RH	476	2 (0.4)	--	0.409[c]

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[c] P-value determined using a chi-square test with continuity correction because of the sparse number of participants with other abnormal ECG diagnoses.
--: Results not presented because of the sparse number of participants with other abnormal ECG diagnoses.

Note: RH = Ranch Hand.
    Comparison: 1987 Dioxin ≤ 10 ppt.
    Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
    Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
    High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-20. Analysis of ECG: Other Diagnoses (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,186		
Background RH	368	2.89 (0.16,52.97)	0.474
Low RH	227	--	--
High RH	239	12.41 (1.00,154.15)	0.050
Low plus High RH	466	--	--

[a] Relative risk and confidence interval relative to Comparisons.
--: Results not presented because of the sparse number of participants with other abnormal ECG diagnoses.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

   Results are not adjusted for occupation, family history of heart disease before age 45, and diabetic class because of the sparse number of participants with other abnormal ECG diagnoses.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log$_2$ (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Yes	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	1 (0.4)	1.27 (0.63,2.59)	0.512
Medium	281	0 (0.0)		
High	287	2 (0.7)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log$_2$ (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
834	1.47 (0.58,3.73)	0.413

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for occupation, current cigarette smoking, family history of heart disease before age 45, and diabetic class because of the sparse number of Ranch Hands with other abnormal ECG diagnoses.

The unadjusted Model 2 analysis revealed no significant results (Table 14-20(c): p=0.381). Because of the sparse number of Ranch Hands with other ECG diagnoses, the adjusted Model 2 analysis was not performed.

The unadjusted and adjusted Model 3 analyses each revealed a significant difference between Ranch Hands in the high dioxin category and Comparisons (Table 14-20(e,f): Est. RR=12.49, p=0.042; Adj. RR=12.41, p=0.050, respectively). The percentage of Ranch Hands in the high dioxin category was 0.8 versus 0.1 percent for the Comparisons.

Both the unadjusted and adjusted Model 4 analyses did not reveal a significant association between 1987 dioxin and other ECG diagnoses (Table 14-20(g,h): p<0.41 for each analysis).

14.2.2.3 Physical Examination Variables − Peripheral Vascular Function

14.2.2.3.1 Funduscopic Examination

The unadjusted and adjusted Model 1 analyses of funduscopic examination did not reveal a group difference between Ranch Hands and Comparisons when all occupations were combined (Table 14-21(a,b): p>0.56 for each contrast). Stratifying by occupation revealed a significant group difference within the enlisted groundcrew stratum in both the unadjusted and adjusted analyses (Table 14-21(a,b): Est. RR=0.62, p=0.033; Adj. RR=0.62, p=0.047, respectively). Ranch Hand enlisted groundcrew had fewer abnormal funduscopic examination results (8.8%) than did Comparison enlisted groundcrew (13.3%).

Table 14-21. Analysis of Funduscopic Examination

(a) MODEL 1: RANCH HANDS VS. COMPARISONS − UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*858*	*105 (12.2)*	*0.96 (0.74,1.25)*	*0.767*
	Comparison	*1,231*	*156 (12.7)*		
Officer	Ranch Hand	333	42 (12.6)	1.28 (0.83,1.99)	0.267
	Comparison	484	49 (10.1)		
Enlisted Flyer	Ranch Hand	149	30 (20.1)	1.21 (0.69,2.09)	0.508
	Comparison	185	32 (17.3)		
Enlisted Groundcrew	Ranch Hand	376	33 (8.8)	0.62 (0.41,0.96)	0.033
	Comparison	562	75 (13.3)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS − ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.92 (0.69,1.22)*	*0.562*
Officer	1.27 (0.79,2.02)	0.321
Enlisted Flyer	1.06 (0.59,1.91)	0.852
Enlisted Groundcrew	0.62 (0.39,0.99)	0.047

Table 14-21. Analysis of Funduscopic Examination (Continued)

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	20 (12.9)	0.93 (0.76,1.15)	0.520
Medium	161	24 (14.9)		
High	160	18 (11.3)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.14 (0.87,1.50)	0.342

[a] Relative risk for a twofold increase in initial dioxin.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,194	149 (12.5)		
Background RH	375	43 (11.5)	0.99 (0.69,1.43)	0.963
Low RH	233	30 (12.9)	1.02 (0.67,1.56)	0.921
High RH	243	32 (13.2)	0.98 (0.65,1.49)	0.933
Low plus High RH	476	62 (13.0)	1.00 (0.73,1.38)	0.993

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-21. Analysis of Funduscopic Examination (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,154		
Background RH	359	1.04 (0.70,1.55)	0.842
Low RH	221	0.82 (0.52,1.30)	0.402
High RH	236	0.95 (0.60,1.51)	0.836
Low plus High RH	457	0.89 (0.63,1.26)	0.500

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	283	30 (10.6)	1.00 (0.87,1.15)	0.951
Medium	281	36 (12.8)		
High	287	39 (13.6)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
816	1.03 (0.85,1.24)	0.767

[a] Relative risk for a twofold increase in 1987 dioxin.

The unadjusted and adjusted analyses in Models 2 through 4 were nonsignificant (Table 14-21(c–h): p>0.34 for each analysis).

14.2.2.3.2   Carotid Bruits

All Model 1 through 4 unadjusted and adjusted analyses were nonsignificant (Table 14-22(a–h): p>0.21 for each analysis).

Table 14-22. Analysis of Carotid Bruits

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*23 (2.7)*	*1.00 (0.58,1.71)*	*0.999*
	Comparison	*1,232*	*33 (2.7)*		
Officer	Ranch Hand	334	6 (1.8)	0.72 (0.27,1.94)	0.515
	Comparison	484	12 (2.5)		
Enlisted Flyer	Ranch Hand	149	8 (5.4)	2.05 (0.66,6.41)	0.215
	Comparison	186	5 (2.7)		
Enlisted Groundcrew	Ranch Hand	376	9 (2.4)	0.84 (0.37,1.91)	0.673
	Comparison	562	16 (2.8)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.94 (0.53,1.65)*	*0.823*
Officer	0.72 (0.26,1.99)	0.524
Enlisted Flyer	1.94 (0.58,6.46)	0.283
Enlisted Groundcrew	0.78 (0.33,1.86)	0.578

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	3 (1.9)	1.06 (0.70,1.59)	0.797
Medium	161	5 (3.1)		
High	160	5 (3.1)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.15 (0.62,2.11)	0.658

[a] Relative risk for a twofold increase in initial dioxin.

Table 14-22. Analysis of Carotid Bruits (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[a][b]	p-Value
Comparison	1,195	31 (2.6)		
Background RH	376	9 (2.4)	0.93 (0.44,1.98)	0.853
Low RH	233	5 (2.1)	0.82 (0.32,2.14)	0.687
High RH	243	8 (3.3)	1.27 (0.57,2.80)	0.561
Low plus High RH	476	13 (2.7)	1.02 (0.53,2.00)	0.943

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin $\leq$ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	1.06 (0.47,2.38)	0.893
Low RH	221	0.69 (0.25,1.86)	0.460
High RH	236	1.01 (0.41,2.45)	0.991
Low plus High RH	457	0.84 (0.41,1.71)	0.625

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin $\leq$ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	7 (2.5)	1.02 (0.77,1.36)	0.897
Medium	281	7 (2.5)		
High	287	8 (2.8)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = $\leq$7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

Table 14-22. Analysis of Carotid Bruits (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED		
Analysis Results for Log$_2$ (1987 Dioxin + 1)		
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
817	0.94 (0.65,1.36)	0.755

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.3.3   Radial Pulses

The unadjusted and adjusted Model 1 analyses of radial pulses were nonsignificant (Table 14-23(a,b): p>0.11 for each contrast).

Table 14-23. Analysis of Radial Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED					
Occupational Category	**Group**	**n**	**Number (%) Abnormal**	**Est. Relative Risk (95% C.I.)**	**p-Value**
All	*Ranch Hand*	*859*	*7 (0.8)*	*2.52 (0.74,8.64)*	*0.131*
	Comparison	*1,232*	*4 (0.3)*		
Officer	Ranch Hand	334	2 (0.6)	1.45 (0.20,10.36)	0.710
	Comparison	484	2 (0.4)		
Enlisted Flyer	Ranch Hand	149	0 (0.0)	--	--
	Comparison	186	0 (0.0)		
Enlisted Groundcrew	Ranch Hand	376	5 (1.3)	3.77 (0.73,19.55)	0.114
	Comparison	562	2 (0.4)		

--: Results not presented because of the sparse number of participants with an abnormal radial pulse.

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED		
Occupational Category	**Adjusted Relative Risk (95% C.I.)**	**p-Value**
All	*2.85 (0.67,12.16)*	*0.143*
Officer	1.24 (0.16,9.95)	0.837
Enlisted Flyer	--	--
Enlisted Groundcrew	5.69 (0.54,60.05)	0.148

--: Results not presented because of the sparse number of participants with an abnormal radial pulse.

Note: Results for all occupations combined are not adjusted for occupation because of the sparse number of participants with an abnormal radial pulse.

Table 14-23. Analysis of Radial Pulses (Continued)

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	2 (1.3)	0.58 (0.17,1.99)	0.334
Medium	161	0 (0.0)		
High	160	1 (0.6)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

Analysis Results for Log_2 (Initial Dioxin)		
n	Adjusted Relative Risk (95% C.I.)	p-Value
--	--	--

--: Results not presented because of the sparse number of Ranch Hands with an abnormal radial pulse.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	4 (0.3)		
Background RH	376	4 (1.1)	2.78 (0.69,11.27)	0.153
Low RH	233	2 (0.9)	2.64 (0.48,14.54)	0.264
High RH	243	1 (0.4)	1.41 (0.16,12.80)	0.759
Low plus High RH	476	3 (0.6)	1.92 (0.40,9.18)	0.414

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-23. Analysis of Radial Pulses (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	3.27 (0.64,16.71)	0.155
Low RH	221	3.82 (0.53,27.51)	0.183
High RH	236	1.26 (0.11,14.89)	0.856
Low plus High RH	457	2.15 (0.36,13.04)	0.404

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

   Results are not adjusted for occupation because of the sparse number of participants with an abnormal radial pulse.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	2 (0.7)	0.75 (0.43,1.32)	0.305
Medium	281	4 (1.4)		
High	287	1 (0.3)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	0.61 (0.30,1.21)	0.140

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Results are not adjusted for occupation because of the sparse number of Ranch Hands with an abnormal radial pulse.

The unadjusted Model 2 analysis showed no significant association between radial pulses and initial dioxin (Table 14-23(c): p=0.334). Because of the sparse number of Ranch Hands with abnormal radial pulses, the adjusted Model 2 analysis was not performed.

All Model 3 and 4 analyses of radial pulses were nonsignificant (Table 14-23(e–h): p≥0.14 for each analysis).

14.2.2.3.4   Femoral Pulses

The unadjusted Model 1 analysis of femoral pulses revealed a marginally significant overall group difference between Ranch Hands and Comparisons (Table 14-24(a): Est. RR=1.83, p=0.080). Stratifying by occupation did not reveal any significant difference between Ranch Hands and Comparisons within each occupational stratum (Table 14-24(a): p>0.12 for each contrast). The percentage of participants with abnormal femoral pulses was greater for the Ranch Hands (2.2%) than for Comparisons (1.2%). The adjusted analysis did not show a significant difference between Ranch Hands and Comparisons over all occupations or within each occupational stratum (Table 14-24(b): p>0.17 for each contrast).

Table 14-24. Analysis of Femoral Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*19 (2.2)*	*1.83 (0.93,3.63)*	*0.080*
	Comparison	*1,231*	*15 (1.2)*		
Officer	Ranch Hand	334	7 (2.1)	1.27 (0.46,3.55)	0.643
	Comparison	484	8 (1.7)		
Enlisted Flyer	Ranch Hand	149	5 (3.4)	2.11 (0.50,8.96)	0.313
	Comparison	185	3 (1.6)		
Enlisted Groundcrew	Ranch Hand	376	7 (1.9)	2.65 (0.77,9.10)	0.123
	Comparison	562	4 (0.7)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.66 (0.79,3.49)*	*0.178*
Officer	1.51 (0.52,4.38)	0.448
Enlisted Flyer	1.48 (0.27,8.02)	0.652
Enlisted Groundcrew	2.08 (0.55,7.87)	0.282

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	3 (1.9)	0.97 (0.61,1.53)	0.890
Medium	161	5 (3.1)		
High	160	4 (2.5)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-24. Analysis of Femoral Pulses (Continued)

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
457	1.17 (0.61,2.24)	0.641

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race because of the sparse number of participants with an abnormal femoral pulse.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,194	15 (1.3)		
Background RH	376	7 (1.9)	1.39 (0.56,3.45)	0.481
Low RH	233	6 (2.6)	2.10 (0.81,5.48)	0.128
High RH	243	6 (2.5)	2.13 (0.81,5.56)	0.125
Low plus High RH	476	12 (2.5)	2.11 (0.98,4.56)	0.056

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
    Comparison: 1987 Dioxin ≤ 10 ppt.
    Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
    Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
    High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,154		
Background RH	360	1.22 (0.44,3.36)	0.702
Low RH	221	1.71 (0.58,4.98)	0.329
High RH	236	2.45 (0.76,7.90)	0.134
Low plus High RH	457	2.06 (0.85,4.96)	0.108

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
    Comparison: 1987 Dioxin ≤ 10 ppt.
    Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
    Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
    High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-24. Analysis of Femoral Pulses (Continued)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	5 (1.8)	1.01 (0.75,1.38)	0.927
Medium	281	5 (1.8)		
High	287	9 (3.1)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	1.29 (0.83,2.03)	0.255

[a] Relative risk for a twofold increase in 1987 dioxin.

The Model 2 analyses did not reveal a significant association between femoral pulses and initial dioxin in either the unadjusted or adjusted analyses (Table 14-24(c,d): p>0.64 for each analysis).

The unadjusted Model 3 analysis showed a marginally significant difference between Ranch Hands in the low plus high dioxin category and Comparisons (Table 14-24(e): Est. RR=2.11, p=0.056). The percentage of abnormal femoral pulses for Ranch Hands in the low plus high dioxin category was 2.5 versus 1.3 percent for Comparisons. The adjusted analysis did not find any contrasts to be significant (Table 14-24(f): p>0.10 for each contrast).

The unadjusted and adjusted Model 4 analyses did not show a significant association between 1987 dioxin and femoral pulses (Table 14-24(g,h): p>0.25 for each analysis).

14.2.2.3.5   Popliteal Pulses

All unadjusted and adjusted Model 1 through 4 analyses were not significant (Table 14-25(a–h): p≥0.41 for each analysis).

Table 14-25. Analysis of Popliteal Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*23 (2.7)*	*1.18 (0.68,2.06)*	*0.561*
	Comparison	*1,230*	*28 (2.3)*		
Officer	Ranch Hand	334	7 (2.1)	0.84 (0.33,2.16)	0.717
	Comparison	483	12 (2.5)		
Enlisted Flyer	Ranch Hand	149	5 (3.4)	1.57 (0.41,5.96)	0.506
	Comparison	185	4 (2.2)		
Enlisted Groundcrew	Ranch Hand	376	11 (2.9)	1.38 (0.60,3.16)	0.445
	Comparison	562	12 (2.1)		

Table 14-25. Analysis of Popliteal Pulses (Continued)

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.04 (0.56,1.90)*	*0.911*
Officer	0.95 (0.35,2.52)	0.911
Enlisted Flyer	0.99 (0.21,4.82)	0.995
Enlisted Groundcrew	1.13 (0.46,2.79)	0.784

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	4 (2.6)	0.89 (0.57,1.38)	0.601
Medium	161	6 (3.7)		
High	160	4 (2.5)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	0.97 (0.53,1.78)	0.924

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for race because of the sparse number of Ranch Hands with an abnormal popliteal pulse.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,193	28 (2.3)		
Background RH	376	9 (2.4)	0.94 (0.44,2.03)	0.879
Low RH	233	7 (3.0)	1.31 (0.56,3.03)	0.535
High RH	243	7 (2.9)	1.33 (0.57,3.08)	0.512
Low plus High RH	476	14 (2.9)	1.32 (0.69,2.53)	0.410

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
      Comparison: 1987 Dioxin ≤ 10 ppt.
      Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
      Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
      High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-25. Analysis of Popliteal Pulses (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY − ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,153		
Background RH	360	0.88 (0.37,2.05)	0.760
Low RH	221	1.15 (0.45,2.92)	0.776
High RH	236	1.08 (0.40,2.86)	0.884
Low plus High RH	457	1.11 (0.53,2.30)	0.781

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
     Comparison: 1987 Dioxin ≤ 10 ppt.
     Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
     Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
     High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS − 1987 DIOXIN − UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	6 (2.1)	0.98 (0.74,1.30)	0.891
Medium	281	7 (2.5)		
High	287	10 (3.5)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS − 1987 DIOXIN − ADJUSTED

	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	1.02 (0.72,1.46)	0.908

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.3.6 *Dorsalis Pedis Pulses*

All unadjusted and adjusted analyses of dorsalis pedis pulses were nonsignificant (Table 14-26(a–h): p>0.11 for each analysis).

Table 14-26. Analysis of Dorsalis Pedis Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*69 (8.0)*	*1.04 (0.76,1.44)*	*0.796*
	Comparison	*1,230*	*95 (7.7)*		
Officer	Ranch Hand	334	27 (8.1)	1.24 (0.73,2.11)	0.429
	Comparison	483	32 (6.6)		
Enlisted Flyer	Ranch Hand	149	18 (12.1)	1.36 (0.67,2.74)	0.392
	Comparison	185	17 (9.2)		
Enlisted Groundcrew	Ranch Hand	376	24 (6.4)	0.76 (0.46,1.28)	0.305
	Comparison	562	46 (8.2)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.97 (0.69,1.37)*	*0.857*
Officer	1.27 (0.73,2.22)	0.398
Enlisted Flyer	1.33 (0.62,2.86)	0.463
Enlisted Groundcrew	0.64 (0.37,1.12)	0.117

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	12 (7.7)	0.90 (0.69,1.17)	0.417
Medium	161	16 (9.9)		
High	160	12 (7.5)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.11 (0.78,1.57)	0.561

[a] Relative risk for a twofold increase in initial dioxin.

Table 14-26. Analysis of Dorsalis Pedis Pulses (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[a][b]	p-Value
Comparison	1,193	95 (8.0)		
Background RH	376	29 (7.7)	0.91 (0.59,1.40)	0.664
Low RH	233	22 (9.4)	1.22 (0.75,1.98)	0.429
High RH	243	18 (7.4)	0.98 (0.58,1.65)	0.931
Low plus High RH	476	40 (8.4)	1.09 (0.74,1.61)	0.670

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
      Comparison: 1987 Dioxin $\leq$ 10 ppt.
      Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
      Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
      High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,153		
Background RH	360	0.94 (0.59,1.50)	0.792
Low RH	221	0.99 (0.58,1.70)	0.977
High RH	236	0.89 (0.50,1.58)	0.685
Low plus High RH	457	0.94 (0.61,1.43)	0.761

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
      Comparison: 1987 Dioxin $\leq$ 10 ppt.
      Background (Ranch Hand): 1987 Dioxin $\leq$ 10 ppt.
      Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin $\leq$ 94 ppt.
      High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	21 (7.4)	0.99 (0.84,1.17)	0.913
Medium	281	25 (8.9)		
High	287	23 (8.0)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = $\leq$7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

Table 14-26. Analysis of Dorsalis Pedis Pulses (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
817	1.07 (0.85,1.33)	0.580

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.3.7   *Posterior Tibial Pulses*

All unadjusted and adjusted Models 1 through 4 analyses of posterior tibial pulses were nonsignificant (Table 14-27(a–h): p>0.11 for each analysis).

Table 14-27. Analysis of Posterior Tibial Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*58 (6.8)*	*1.32 (0.91,1.90)*	*0.142*
	Comparison	*1,228*	*64 (5.2)*		
Officer	Ranch Hand	334	22 (6.6)	1.41 (0.77,2.57)	0.263
	Comparison	483	23 (4.8)		
Enlisted Flyer	Ranch Hand	149	14 (9.4)	1.36 (0.62,2.98)	0.449
	Comparison	183	13 (7.1)		
Enlisted Groundcrew	Ranch Hand	376	22 (5.9)	1.19 (0.67,2.10)	0.562
	Comparison	562	28 (5.0)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.25 (0.84,1.86)*	*0.280*
Officer	1.40 (0.73,2.68)	0.307
Enlisted Flyer	1.17 (0.49,2.78)	0.724
Enlisted Groundcrew	1.16 (0.62,2.16)	0.649

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	9 (5.8)	1.01 (0.77,1.33)	0.925
Medium	161	15 (9.3)		
High	160	10 (6.3)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-27. Analysis of Posterior Tibial Pulses (Continued)

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
	Adjusted Relative Risk	
n	**(95% C.I.)[a]**	**p-Value**
457	1.16 (0.81,1.65)	0.417

[a] Relative risk for a twofold increase in initial dioxin.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,191	63 (5.3)		
Background RH	376	22 (5.9)	1.04 (0.63,1.73)	0.865
Low RH	233	18 (7.7)	1.52 (0.88,2.61)	0.135
High RH	243	16 (6.6)	1.34 (0.76,2.36)	0.320
Low plus High RH	476	34 (7.1)	1.42 (0.92,2.19)	0.113

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
    Comparison: 1987 Dioxin ≤ 10 ppt.
    Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
    Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
    High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,151		
Background RH	360	1.08 (0.62,1.89)	0.784
Low RH	221	1.31 (0.71,2.39)	0.387
High RH	236	1.21 (0.63,2.30)	0.571
Low plus High RH	457	1.25 (0.77,2.03)	0.358

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
    Comparison: 1987 Dioxin ≤ 10 ppt.
    Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
    Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
    High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-27. Analysis of Posterior Tibial Pulses (Continued)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	18 (6.3)	1.03 (0.86,1.24)	0.746
Medium	281	16 (5.7)		
High	287	22 (7.7)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	1.12 (0.88,1.43)	0.354

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.3.8   *Leg Pulses*

Leg pulses were not significantly associated with dioxin in any of the unadjusted and adjusted Models 1 through 4 analyses (Table 14-28(a–h): p>0.15 for each analysis).

Table 14-28. Analysis of Leg Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*94 (10.9)*	*1.10 (0.83,1.47)*	*0.496*
	Comparison	*1,228*	*123 (10.0)*		
Officer	Ranch Hand	334	36 (10.8)	1.34 (0.83,2.15)	0.228
	Comparison	483	40 (8.3)		
Enlisted Flyer	Ranch Hand	149	25 (16.8)	1.48 (0.79,2.74)	0.218
	Comparison	183	22 (12.0)		
Enlisted Groundcrew	Ranch Hand	376	33 (8.8)	0.79 (0.51,1.23)	0.300
	Comparison	562	61 (10.9)		

Table 14-28. Analysis of Leg Pulses (Continued)

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.03 (0.76,1.40)*	*0.850*
Officer	1.30 (0.79,2.16)	0.306
Enlisted Flyer	1.46 (0.74,2.88)	0.270
Enlisted Groundcrew	0.71 (0.44,1.14)	0.158

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	15 (9.7)	0.96 (0.77,1.20)	0.739
Medium	161	22 (13.7)		
High	160	16 (10.0)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.13 (0.84,1.51)	0.433

[a] Relative risk for a twofold increase in initial dioxin.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,191	122 (10.2)		
Background RH	376	39 (10.4)	0.95 (0.65,1.40)	0.812
Low RH	233	29 (12.4)	1.26 (0.82,1.94)	0.298
High RH	243	24 (9.9)	1.01 (0.64,1.61)	0.957
Low plus High RH	476	53 (11.1)	1.13 (0.80,1.59)	0.498

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-28. Analysis of Leg Pulses (Continued)

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,151		
Background RH	360	1.01 (0.66,1.53)	0.981
Low RH	221	1.01 (0.63,1.64)	0.955
High RH	236	0.91 (0.54,1.53)	0.725
Low plus High RH	457	0.96 (0.66,1.40)	0.832

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
       Comparison: 1987 Dioxin ≤ 10 ppt.
       Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
       Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
       High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	30 (10.6)	1.00 (0.87,1.16)	0.956
Medium	281	31 (11.0)		
High	287	31 (10.8)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	1.08 (0.88,1.31)	0.467

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.3.9   Peripheral Pulses

All unadjusted and adjusted analyses in Models 1 through 4 were nonsignificant (Table 14–29(a–h): p>0.21 for each analysis).

Table 14-29. Analysis of Peripheral Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*859*	*97 (11.3)*	*1.11 (0.84,1.47)*	*0.454*
	Comparison	*1,228*	*126 (10.3)*		
Officer	Ranch Hand	334	37 (11.1)	1.31 (0.82,2.08)	0.258
	Comparison	483	42 (8.7)		
Enlisted Flyer	Ranch Hand	149	25 (16.8)	1.48 (0.79,2.74)	0.218
	Comparison	183	22 (12.0)		
Enlisted Groundcrew	Ranch Hand	376	35 (9.3)	0.83 (0.53,1.28)	0.396
	Comparison	562	62 (11.0)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*1.05 (0.77,1.42)*	*0.761*
Officer	1.27 (0.77,2.09)	0.353
Enlisted Flyer	1.48 (0.75,2.92)	0.260
Enlisted Groundcrew	0.75 (0.47,1.21)	0.242

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[b]	p-Value
Low	155	16 (10.3)	0.96 (0.77,1.19)	0.703
Medium	161	22 (13.7)		
High	160	17 (10.6)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
457	1.06 (0.79,1.41)	0.718

[a] Relative risk for a twofold increase in initial dioxin.

Table 14-29. Analysis of Peripheral Pulses (Continued)

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[a][b]	p-Value
Comparison	1,191	125 (10.5)		
Background RH	376	40 (10.6)	0.95 (0.65,1.39)	0.797
Low RH	233	30 (12.9)	1.27 (0.83,1.95)	0.266
High RH	243	25 (10.3)	1.04 (0.66,1.63)	0.880
Low plus High RH	476	55 (11.6)	1.15 (0.82,1.61)	0.431

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,151		
Background RH	360	1.00 (0.66,1.52)	0.997
Low RH	221	1.05 (0.65,1.70)	0.833
High RH	236	0.94 (0.57,1.57)	0.828
Low plus High RH	457	1.00 (0.68,1.45)	0.981

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	284	31 (10.9)	1.00 (0.86,1.15)	0.972
Medium	281	32 (11.4)		
High	287	32 (11.1)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

Table 14-29. Analysis of Peripheral Pulses (Continued)

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

	Analysis Results for Log_2 (1987 Dioxin + 1)	
n	**Adjusted Relative Risk (95% C.I.)[a]**	**p-Value**
817	1.07 (0.88,1.30)	0.485

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.2.3.10   ICVI Index

The analysis of ICVI index did not show any significant associations with dioxin (Table 14-30(a–h): p>0.11 for each analysis).

Table 14-30. Analysis of ICVI Index

(a) MODEL 1: RANCH HANDS VS. COMPARISONS – UNADJUSTED

Occupational Category	Group	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)	p-Value
All	*Ranch Hand*	*858*	*33 (3.8)*	*1.06 (0.67,1.67)*	*0.819*
	Comparison	*1,232*	*45 (3.7)*		
Officer	Ranch Hand	334	13 (3.9)	1.27 (0.59,2.70)	0.541
	Comparison	484	15 (3.1)		
Enlisted Flyer	Ranch Hand	149	7 (4.7)	0.71 (0.27,1.86)	0.492
	Comparison	186	12 (6.5)		
Enlisted Groundcrew	Ranch Hand	375	13 (3.5)	1.09 (0.53,2.24)	0.825
	Comparison	562	18 (3.2)		

(b) MODEL 1: RANCH HANDS VS. COMPARISONS – ADJUSTED

Occupational Category	Adjusted Relative Risk (95% C.I.)	p-Value
All	*0.99 (0.61,1.60)*	*0.958*
Officer	1.25 (0.57,2.70)	0.577
Enlisted Flyer	0.50 (0.17,1.51)	0.218
Enlisted Groundcrew	1.12 (0.53,2.39)	0.764

(c) MODEL 2: RANCH HANDS – INITIAL DIOXIN – UNADJUSTED

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
Initial Dioxin	**n**	**Number (%) Abnormal**	**Estimated Relative Risk (95% C.I.)[b]**	**p-Value**
Low	155	6 (3.9)	0.99 (0.71,1.37)	0.948
Medium	161	10 (6.2)		
High	160	7 (4.4)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Table 14-30. Analysis of ICVI Index (Continued)

(d) MODEL 2: RANCH HANDS – INITIAL DIOXIN – ADJUSTED

	Analysis Results for Log_2 (Initial Dioxin)	
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
461	1.12 (0.73,1.72)	0.604

[a] Relative risk for a twofold increase in initial dioxin.

Note: Results are not adjusted for diabetic class because of the sparse number of Ranch Hands with an abnormal intermittent claudication and vascular insufficiency index.

(e) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – UNADJUSTED

Dioxin Category	n	Number (%) Abnormal	Est. Relative Risk (95% C.I.)[ab]	p-Value
Comparison	1,195	43 (3.6)		
Background RH	375	9 (2.4)	0.65 (0.31,1.35)	0.249
Low RH	233	9 (3.9)	1.08 (0.52,2.24)	0.839
High RH	243	14 (5.8)	1.66 (0.89,3.09)	0.112
Low plus High RH	476	23 (4.8)	1.34 (0.79,2.27)	0.272

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin.

Note: RH = Ranch Hand.
  Comparison: 1987 Dioxin ≤ 10 ppt.
  Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
  Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
  High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

(f) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY – ADJUSTED

Dioxin Category	n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
Comparison	1,155		
Background RH	360	0.69 (0.32,1.48)	0.340
Low RH	221	0.98 (0.46,2.11)	0.968
High RH	236	1.41 (0.69,2.89)	0.346
Low plus High RH	457	1.19 (0.67,2.09)	0.555

[a] Relative risk and confidence interval relative to Comparisons.

Note: RH = Ranch Hand.
  Comparison: 1987 Dioxin ≤ 10 ppt.
  Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
  Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
  High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

Table 14-30. Analysis of ICVI Index (Continued)

(g) MODEL 4: RANCH HANDS – 1987 DIOXIN – UNADJUSTED

1987 Dioxin Category Summary Statistics			Analysis Results for Log_2 (1987 Dioxin + 1)	
1987 Dioxin	n	Number (%) Abnormal	Estimated Relative Risk (95% C.I.)[a]	p-Value
Low	283	8 (2.8)	1.08 (0.86,1.37)	0.503
Medium	281	9 (3.2)		
High	287	15 (5.2)		

[a] Relative risk for a twofold increase in 1987 dioxin.

Note: Low = ≤7.9 ppt; Medium = >7.9–19.6 ppt; High = >19.6 ppt.

(h) MODEL 4: RANCH HANDS – 1987 DIOXIN – ADJUSTED

Analysis Results for Log_2 (1987 Dioxin + 1)		
n	Adjusted Relative Risk (95% C.I.)[a]	p-Value
817	1.07 (0.79,1.45)	0.666

[a] Relative risk for a twofold increase in 1987 dioxin.

14.2.3   Longitudinal Analysis

Cardiovascular longitudinal analyses were conducted on systolic blood pressure measurements taken at the 1982 and 1997 examinations and six pulse assessments made at the 1985 and 1997 examinations. Discrete and continuous analyses were performed for systolic blood pressure. The six pulse measurements included femoral pulses, popliteal pulses, dorsalis pedis pulses, posterior tibial pulses, leg pulses, and peripheral pulses. The 1985 and 1997 measurements were used for the pulse assessments because the Doppler assessment of pulses was conducted at these two examinations and was not conducted at the 1982 baseline or 1987 follow-up examinations.

Longitudinal analyses were conducted to examine whether changes across time differed with respect to group membership (Model 1), initial dioxin (Model 2), and categorized dioxin (Model 3). Model 4 was not examined in longitudinal analyses because 1987 dioxin, the measure of exposure in these models, changes over time and is not available for all participants for 1982 or 1997.

Participants considered abnormal in 1982 (or 1985 for Doppler pulse measurements) were not included in the longitudinal analysis of discrete dependent variables. The purpose of the longitudinal analysis was to examine the effects of dioxin exposure across time. Participants who were abnormal in 1982 (or 1988) were not considered to be at risk for developing the condition, because the condition already existed at the time of the first collection of data for the AFHS (1982). Only participants who were normal at the 1982 (or 1985) examination were considered to be at risk for developing the condition; therefore, the rate of abnormalities under this restriction approximates an incidence rate between 1982 (or 1985) and 1997. That is, an incidence rate is a measure of the rate at which people without a condition develop the condition during a specified period of time (53). Summary statistics are provided for reference purposes for the 1985, 1987, and 1992 examinations for systolic blood pressure and for the 1992 examination for the pulse measurements.

The longitudinal analysis for systolic blood pressure in its discrete form examined relative risks at the 1997 examination for participants who were classified as normal at the 1982 examination. The longitudinal analysis for the Doppler pulse measurements examined relative risks at the 1997 examination for participants who were classified as normal at the 1985 examination. The adjusted relative risks estimated from each of the three models were used to investigate the change in the dependent variable over time. All three models were adjusted for age; Models 2 and 3 also were adjusted for the percentage of body fat at the time of the blood measurement of dioxin.

The longitudinal analysis for the systolic blood pressure in its continuous form examined the paired difference between the measurements from 1982 and 1997. These paired differences measured the change in systolic blood pressure over time. Each of the three models used in the longitudinal analysis was adjusted for age and systolic blood pressure as measured in 1982 (see Chapter 7, Statistical Methods).

14.2.3.1 Physical Examination Variables

14.2.3.1.1   Systolic Blood Pressure (Continuous)

The Model 1 analysis of change in mean systolic blood pressure revealed a marginally significant difference between overall Ranch Hands and Comparisons (Table 14-31(a): difference of examination mean change=−1.6 mm Hg, p=0.066). The Ranch Hand mean decreased by 6.3 mm Hg between 1982 and 1997, and the Comparison mean decreased by 4.7 mm Hg. Stratifying by occupation showed a marginally significant group difference in the enlisted groundcrew stratum (Table 14-31(a): difference of examination mean change=−2.2 mm Hg, p=0.079). For the enlisted groundcrew, the Ranch Hand mean decreased by 7.4 mm Hg between 1982 and 1997, and the Comparison mean decreased by 5.2 mm Hg.

Table 14-31. Longitudinal Analysis of Systolic Blood Pressure (mm Hg) (Continuous)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS									

Occupational Category	Group	Mean[a]/(n) Examination					Exam. Mean Change[b]	Difference of Exam. Mean Change	p-Value[c]
		1982	1985	1987	1992	1997			
All	*Ranch Hand*	*131.1 (808)*	*117.8 (790)*	*125.9 (782)*	*120.4 (785)*	*124.8 (808)*	*−6.3*	*−1.6*	*0.066*
	Comparison	*130.7 (959)*	*118.9 (940)*	*126.4 (935)*	*121.3 (939)*	*126.0 (959)*	*−4.7*		
Officer	Ranch Hand	131.8 (305)	118.8 (301)	126.5 (298)	122.6 (300)	126.1 (305)	−5.6	−0.3	0.840
	Comparison	131.3 (372)	118.8 (365)	126.3 (360)	121.8 (367)	126.1 (372)	−5.3		
Enlisted Flyer	Ranch Hand	131.8 (146)	118.4 (143)	127.2 (141)	120.6 (142)	126.7 (146)	−5.1	−3.8	0.135
	Comparison	130.2 (144)	118.9 (143)	125.9 (142)	121.2 (142)	128.9 (144)	−1.3		
Enlisted Groundcrew	Ranch Hand	130.3 (357)	116.8 (346)	124.8 (343)	118.4 (343)	122.9 (357)	−7.4	−2.2	0.079
	Comparison	130.3 (443)	119.0 (432)	126.7 (433)	120.9 (430)	125.1 (443)	−5.2		

[a] Transformed from natural logarithm scale.
[b] Difference between 1997 and 1982 examination means after transformation to original scale.
[c] P-value is based on analysis of natural logarithm of systolic blood pressure; results adjusted for natural logarithm of systolic blood pressure in 1982 and age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

(b) MODEL 2: RANCH HANDS – INITIAL DIOXIN							
Initial Dioxin Category Summary Statistics						**Analysis Results for Log$_2$ (Initial Dioxin)[b]**	
	Mean[a]/(n) Examination						
Initial Dioxin	**1982**	**1985**	**1987**	**1992**	**1997**	**Adjusted Slope (Std. Error)**	**p-Value**
Low	132.2 (149)	118.4 (146)	127.1 (148)	120.5 (144)	125.9 (149)	0.000 (0.005)	0.977
Medium	132.8 (158)	119.7 (155)	126.4 (155)	122.9 (155)	125.5 (158)		
High	131.2 (153)	119.1 (150)	127.4 (148)	121.1 (150)	124.1 (153)		

[a] Transformed from natural logarithm scale.
[b] Results based on difference between natural logarithm of 1997 systolic blood pressure and natural logarithm of 1982 systolic blood pressure versus log$_2$ (initial dioxin); results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 systolic blood pressure, and age in 1997.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

Dioxin Category	Mean[a]/(n) Examination					Exam. Mean Change[b]	Difference of Exam. Mean Change	p-Value[c]
	1982	1985	1987	1992	1997			
Comparison	130.6 (932)	118.7 (916)	126.2 (910)	121.1 (913)	126.0 (932)	−4.7		
Background RH	129.8 (342)	116.2 (334)	124.4 (326)	119.0 (331)	124.4 (342)	−5.3	−0.6	0.386
Low RH	132.0 (224)	118.7 (218)	126.8 (221)	120.9 (217)	126.0 (224)	−6.0	−1.3	0.347
High RH	132.1 (236)	119.5 (233)	127.2 (230)	122.0 (232)	124.4 (236)	−7.8	−3.1	0.086
Low plus High RH	132.1 (460)	119.1 (451)	127.0 (451)	121.5 (449)	125.2 (460)	−6.9	−2.2	0.083

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

[a] Transformed from natural logarithm scale.

[b] Difference between 1997 and 1982 examination means after transformation to original scale.

[c] P-value is based on analysis of natural logarithm of 1997 systolic blood pressure; results adjusted for percent body fat at the date of the blood measurement of dioxin, natural logarithm of 1982 systolic blood pressure, and age in 1997.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin > 10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin > 10 ppt, Initial Dioxin > 94 ppt.

   Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations.

The longitudinal analysis in Model 2 did not reveal a significant association between the change in mean systolic blood pressure and dioxin (Table 14-31(b): p=0.977).

The Model 3 analysis of the change in mean systolic blood pressure levels between 1982 and 1997 revealed two marginally significant contrasts: Ranch Hands in the high dioxin category versus Comparisons (Table 14-31(c): difference of examination mean change=−3.1 mm Hg, p=0.086) and Ranch Hands in the low plus high dioxin category versus Comparisons (Table 14-31(c): difference of examination mean change=−2.2 mm Hg, p=0.083). The change in means between 1982 and 1997 for Ranch Hands in the high dioxin category, Ranch Hands in the low plus high dioxin category, and Comparisons was –7.8 mm Hg, −6.9 mm Hg, and –4.7 mm Hg, respectively.

14.2.3.1.2   Systolic Blood Pressure (Discrete)

The longitudinal analysis in Models 1 through 3 did not reveal a significant association between dioxin and change in systolic blood pressure in its discrete form (Table 14-32(a–c): p>0.45 for each analysis).

Table 14-32. Longitudinal Analysis of Systolic Blood Pressure (Discrete)

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) High/(n) Examination				
		1982	1985	1987	1992	1997
All	*Ranch Hand*	*141 (17.5) (808)*	*42 (5.3) (790)*	*146 (18.7) (782)*	*119 (15.2) (785)*	*169 (20.9) (808)*
	Comparison	*187 (19.5) (959)*	*65 (6.9) (940)*	*205 (21.9) (935)*	*146 (15.5) (939)*	*215 (22.4) (959)*
Officer	Ranch Hand	60 (19.7) (305)	20 (6.6) (301)	59 (19.8) (298)	51 (17.0) (300)	73 (23.9) (305)
	Comparison	75 (20.2) (372)	25 (6.8) (365)	81 (22.5) (360)	65 (17.7) (367)	90 (24.2) (372)
Enlisted Flyer	Ranch Hand	28 (19.2) (146)	5 (3.5) (143)	29 (20.6) (141)	23 (16.2) (142)	35 (24.0) (146)
	Comparison	27 (18.8) (144)	11 (7.7) (143)	31 (21.8) (142)	20 (14.1) (142)	38 (26.4) (144)
Enlisted Groundcrew	Ranch Hand	53 (14.8) (357)	17 (4.9) (346)	58 (16.9) (343)	45 (13.1) (343)	61 (17.1) (357)
	Comparison	85 (19.2) (443)	29 (6.7) (432)	93 (21.5) (433)	61 (14.2) (430)	87 (19.6) (443)

Occupational Category	Group	Normal in 1982		Adj. Relative Risk (95% C.I.)[a]	p-Value[a]
		n in 1997	Number (%) High in 1997		
All	*Ranch Hand*	*667*	*111 (16.6)*	*0.99 (0.75,1.31)*	*0.951*
	Comparison	*772*	*130 (16.8)*		
Officer	Ranch Hand	245	48 (19.6)	1.18 (0.76,1.84)	0.454
	Comparison	297	50 (16.8)		
Enlisted Flyer	Ranch Hand	118	23 (19.5)	0.90 (0.47,1.71)	0.743
	Comparison	117	25 (21.4)		
Enlisted Groundcrew	Ranch Hand	304	40 (13.2)	0.86 (0.55,1.35)	0.513
	Comparison	358	55 (15.4)		

[a] Relative risk, confidence interval, and p-values are in reference to a contrast of 1982 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had normal systolic blood pressure in 1982 (see Chapter 7, Statistical Methods).

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Low	32 (21.5) (149)	6 (4.1) (146)	33 (22.3) (148)	24 (16.7) (144)	37 (24.8) (149)
Medium	32 (20.3) (158)	8 (5.2) (155)	28 (18.1) (155)	28 (18.1) (155)	34 (21.5) (158)
High	22 (14.4) (153)	11 (7.3) (150)	30 (20.3) (148)	25 (16.7) (150)	28 (18.3) (153)

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
	Normal in 1982			
Initial Dioxin	n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.)[b]	p-Value
Low	117	22 (18.8)	0.96 (0.78,1.19)	0.714
Medium	126	23 (18.3)		
High	131	20 (15.3)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had normal systolic blood pressure in 1982 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) High/(n) Examination				
	1982	1985	1987	1992	1997
Comparison	180 (19.3) (932)	60 (6.6) (916)	194 (21.3) (910)	140 (15.3) (913)	207 (22.2) (932)
Background RH	54 (15.8) (342)	17 (5.1) (334)	54 (16.6) (326)	42 (12.7) (331)	69 (20.2) (342)
Low RH	43 (19.2) (224)	8 (3.7) (218)	44 (19.9) (221)	35 (16.1) (217)	54 (24.1) (224)
High RH	43 (18.2) (236)	17 (7.3) (233)	47 (20.4) (230)	42 (18.1) (232)	45 (19.1) (236)
Low plus High RH	86 (18.7) (460)	25 (5.5) (451)	91 (20.2) (451)	77 (17.1) (449)	99 (21.5) (460)

Table 14-32. Longitudinal Analysis of Systolic Blood Pressure (Discrete) (Continued)

Dioxin Category	n in 1997	Number (%) High in 1997	Adj. Relative Risk (95% C.I.)[ab]	p-Value[b]
		Normal in 1982		
Comparison	752	127 (16.9)		
Background RH	288	45 (15.6)	0.96 (0.66,1.41)	0.840
Low RH	181	34 (18.8)	1.01 (0.65,1.55)	0.978
High RH	193	31 (16.1)	1.01 (0.65,1.57)	0.965
Low plus High RH	374	65 (17.4)	1.01 (0.72,1.41)	0.963

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997
.
Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin > 94 ppt.

   Summary statistics for 1985 are provided for reference purposes for participants who attended the 1982, 1985, and 1997 examinations. Summary statistics for 1987 are provided for reference purposes for participants who attended the 1982, 1987, and 1997 examinations. Summary statistics for 1992 are provided for reference purposes for participants who attended the 1982, 1992, and 1997 examinations. Statistical analyses are based only on participants who had normal systolic blood pressure in 1982 (see Chapter 7, Statistical Methods).

14.2.3.1.3   *Femoral Pulses*

The Model 1 analysis of the change in percentage of abnormal femoral pulses did not reveal a significant difference between Ranch Hands and Comparisons overall (Table 14-33(a): p=0.118). Stratifying by occupation showed a marginally significant group difference in the enlisted groundcrew stratum (Table 14-33(a): Adj. RR=3.19, p=0.095). For enlisted groundcrew, 1.9 percent of the Ranch Hands and 0.6 percent of the Comparisons had normal femoral pulses in 1985 and abnormal femoral pulses in 1997.

The Model 2 longitudinal analysis revealed no significant association between dioxin and the percentage of participants with normal femoral pulses in 1985 and abnormal femoral pulses in 1997 (Table 14-33(b): p=0.972).

Table 14-33. Longitudinal Analysis of Femoral Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) Abnormal/(n) Examination		
		1985	1992	1997
All	*Ranch Hand*	*0 (0.0)*	*6 (0.7)*	*19 (2.3)*
		(823)	*(802)*	*(823)*
	Comparison	*0 (0.0)*	*6 (0.6)*	*14 (1.3)*
		(1,047)	*(1,020)*	*(1,047)*
Officer	Ranch Hand	0 (0.0)	4 (1.3)	7 (2.2)
		(318)	(313)	(318)
	Comparison	0 (0.0)	2 (0.5)	8 (1.9)
		(412)	(405)	(412)
Enlisted Flyer	Ranch Hand	0 (0.0)	0 (0.0)	5 (3.4)
		(145)	(143)	(145)
	Comparison	0 (0.0)	2 (1.3)	3 (1.9)
		(158)	(156)	(158)
Enlisted Groundcrew	Ranch Hand	0 (0.0)	2 (0.6)	7 (1.9)
		(360)	(346)	(360)
	Comparison	0 (0.0)	2 (0.4)	3 (0.6)
		(477)	(459)	(477)

Occupational Category	Group	Normal in 1985		Adj. Relative Risk (95% C.I.)[a]	p-Value[a]
		n in 1997	Number (%) Abnormal in 1997		
All	*Ranch Hand*	*823*	*19 (2.3)*	*1.74 (0.86,3.49)*	*0.118*
	Comparison	*1,047*	*14 (1.3)*		
Officer	Ranch Hand	318	7 (2.2)	1.12 (0.40,3.13)	0.824
	Comparison	412	8 (1.9)		
Enlisted Flyer	Ranch Hand	145	5 (3.4)	1.82 (0.43,7.77)	0.419
	Comparison	158	3 (1.9)		
Enlisted Groundcrew	Ranch Hand	360	7 (1.9)	3.19 (0.82,12.42)	0.095
	Comparison	477	3 (0.6)		

[a] Relative risk, confidence interval, and p-values are in reference to a contrast of 1985 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal femoral pulses in 1985 (see Chapter 7, Statistical Methods).

Table 14-33. Longitudinal Analysis of Femoral Pulses (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

	Number (%) Abnormal/(n) Examination		
Initial Dioxin	**1985**	**1992**	**1997**
Low	0 (0.0) (149)	3 (2.1) (144)	3 (2.0) (149)
Medium	0 (0.0) (158)	1 (0.6) (155)	5 (3.2) (158)
High	0 (0.0) (155)	0 (0.0) (151)	4 (2.6) (155)

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
	Normal in 1985			
Initial Dioxin	**n in 1997**	**Number (%) Abnormal in 1997**	**Adj. Relative Risk (95% C.I.)[b]**	**p-Value**
Low	149	3 (2.0)	1.01 (0.63,1.61)	0.972
Medium	158	5 (3.2)		
High	155	4 (2.6)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal femoral pulses in 1985 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

	Number (%) Abnormal/(n) Examination		
Dioxin Category	**1985**	**1992**	**1997**
Comparison	0 (0.0) (1,019)	6 (0.6) (994)	14 (1.4) (1,019)
Background RH	0 (0.0) (355)	2 (0.6) (346)	7 (2.0) (355)
Low RH	0 (0.0) (224)	4 (1.8) (217)	6 (2.7) (224)
High RH	0 (0.0) (238)	0 (0.0) (233)	6 (2.5) (238)
Low plus High RH	0 (0.0) (462)	4 (0.9) (450)	12 (2.6) (462)

Table 14-33. Longitudinal Analysis of Femoral Pulses (Continued)

Dioxin Category	Normal in 1985		Adj. Relative Risk (95% C.I.)[a,b]	p-Value[b]
	n in 1997	Number (%) Abnormal in 1997		
Comparison	1,019	14 (1.4)		
Background RH	355	7 (2.0)	1.28 (0.51,3.21)	0.602
Low RH	224	6 (2.7)	1.88 (0.71,4.98)	0.202
High RH	238	6 (2.5)	2.34 (0.87,6.25)	0.091
Low plus High RH	462	12 (2.6)	2.10 (0.96,4.62)	0.063

[a] Relative risk and confidence interval relative to Comparisons.

[b] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.

 Comparison: 1987 Dioxin ≤ 10 ppt.

 Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.

 Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.

 High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin > 94 ppt.

 Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal femoral pulses in 1985 (see Chapter 7, Statistical Methods).

Model 3 analysis of the change in femoral pulses from normal in 1985 to abnormal in 1997 revealed two marginally significant contrasts: Ranch Hands in the high dioxin category versus Comparisons (Table 14-33(c): Adj. RR=2.34, p=0.091) and Ranch Hands in the low plus high dioxin category versus Comparisons (Table 14-33(c): Adj. RR=2.10, p=0.063). Of the Comparisons, 1.4 percent had normal femoral pulses in 1985 and abnormal femoral pulses in 1997. Of the Ranch Hands, 2.5 percent in the high dioxin category and 2.6 percent in the low plus high dioxin category had normal femoral pulses in 1985 and abnormal femoral pulses in 1997.

14.2.3.1.4   Popliteal Pulses

Analyses of Models 1 through 3 showed no significant associations between dioxin and the change in popliteal pulses between 1985 and 1997 (Table 14-34(a–c): p>0.19 for each analysis).

Table 14-34. Longitudinal Analysis of Popliteal Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) Abnormal/(n) Examination		
		1985	1992	1997
All	*Ranch Hand*	*2 (0.2)* *(823)*	*10 (1.2)* *(802)*	*23 (2.8)* *(823)*
	Comparison	*1 (0.1)* *(1,046)*	*7 (0.7)* *(1,019)*	*24 (2.3)* *(1,046)*
Officer	Ranch Hand	1 (0.3) (318)	6 (1.9) (313)	7 (2.2) (318)
	Comparison	0 (0.0) (411)	4 (1.0) (404)	11 (2.7) (411)
Enlisted Flyer	Ranch Hand	0 (0.0) (145)	2 (1.4) (143)	5 (3.4) (145)
	Comparison	1 (0.6) (158)	2 (1.3) (156)	3 (1.9) (158)
Enlisted Groundcrew	Ranch Hand	1 (0.3) (360)	2 (0.6) (346)	11 (3.1) (360)
	Comparison	0 (0.0) (477)	1 (0.2) (459)	10 (2.1) (477)

Occupational Category	Group	Normal in 1985		Adj. Relative Risk (95% C.I.)[a]	p-Value[a]
		n in 1997	Number (%) Abnormal in 1997		
All	*Ranch Hand*	*821*	*22 (2.7)*	*1.22 (0.67,2.21)*	*0.518*
	Comparison	*1,045*	*23 (2.2)*		
Officer	Ranch Hand	317	7 (2.2)	0.81 (0.31,2.13)	0.672
	Comparison	411	11 (2.7)		
Enlisted Flyer	Ranch Hand	145	5 (3.4)	2.67 (0.51,14.07)	0.246
	Comparison	157	2 (1.3)		
Enlisted Groundcrew	Ranch Hand	359	10 (2.8)	1.39 (0.57,3.40)	0.473
	Comparison	477	10 (2.1)		

[a] Relative risk, confidence interval, and p-values are in reference to a contrast of 1985 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal popliteal pulses in 1985 (see Chapter 7, Statistical Methods).

Table 14-34. Longitudinal Analysis of Popliteal Pulses (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) Abnormal/(n) Examination		
	1985	**1992**	**1997**
Low	0 (0.0)	3 (2.1)	4 (2.7)
	(149)	(144)	(149)
Medium	0 (0.0)	2 (1.3)	6 (3.8)
	(158)	(155)	(158)
High	0 (0.0)	2 (1.3)	4 (2.6)
	(155)	(151)	(155)

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
	Normal in 1985			
Initial Dioxin	**n in 1997**	**Number (%) Abnormal in 1997**	**Adj. Relative Risk (95% C.I.)[b]**	**p-Value**
Low	149	4 (2.7)	0.95 (0.61,1.49)	0.838
Medium	158	6 (3.8)		
High	155	4 (2.6)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal popliteal pulses in 1985 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) Abnormal/(n) Examination		
	1985	**1992**	**1997**
Comparison	1 (0.1)	7 (0.7)	24 (2.4)
	(1,018)	(993)	(1,018)
Background RH	2 (0.6)	3 (0.9)	9 (2.5)
	(355)	(346)	(355)
Low RH	0 (0.0)	4 (1.8)	7 (3.1)
	(224)	(217)	(224)
High RH	0 (0.0)	3 (1.3)	7 (2.9)
	(238)	(233)	(238)
Low plus High RH	0 (0.0)	7 (1.6)	14 (3.0)
	(462)	(450)	(462)

Table 14-34. Longitudinal Analysis of Popliteal Pulses (Continued)

Dioxin Category	n in 1997	Number (%) Abnormal in 1997	Adj. Relative Risk (95% C.I.)[a][b]	p-Value[b]
		Normal in 1985		
Comparison	1,017	23 (2.3)		
Background RH	353	8 (2.3)	0.87 (0.38,1.97)	0.731
Low RH	224	7 (3.1)	1.30 (0.55,3.09)	0.555
High RH	238	7 (2.9)	1.79 (0.75,4.30)	0.193
Low plus High RH	462	14 (3.0)	1.53 (0.77,3.03)	0.221

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.
   Comparison: 1987 Dioxin ≤ 10 ppt.
   Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
   Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
   High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin > 94 ppt.

   Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal popliteal pulses in 1985 (see Chapter 7, Statistical Methods).

14.2.3.1.5   Dorsalis Pedis Pulses

The longitudinal analyses in Models 1 through 3 did not reveal any significant associations between dioxin and the change in dorsalis pedis pulses (Table 14-35(a–c): p>0.33 for each analysis).

Table 14-35. Longitudinal Analysis of Dorsalis Pedis Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) Abnormal/(n) Examination		
		1985	1992	1997
All	*Ranch Hand*	*94 (11.4) (821)*	*60 (7.5) (798)*	*67 (8.2) (821)*
	Comparison	*111 (10.6) (1,044)*	*70 (6.9) (1,017)*	*85 (8.1) (1,044)*
Officer	Ranch Hand	41 (12.9) (318)	23 (7.4) (312)	27 (8.5) (318)
	Comparison	43 (10.5) (409)	28 (7.0) (402)	30 (7.3) (409)
Enlisted Flyer	Ranch Hand	16 (11.0) (145)	9 (6.3) (143)	18 (12.4) (145)
	Comparison	23 (14.6) (158)	16 (10.3) (156)	13 (8.2) (158)
Enlisted Groundcrew	Ranch Hand	37 (10.3) (358)	28 (8.2) (343)	22 (6.1) (358)
	Comparison	45 (9.4) (477)	26 (5.7) (459)	42 (8.8) (477)

Table 14-35. Longitudinal Analysis of Dorsalis Pedis Pulses (Continued)

Occupational Category	Group	Normal in 1985		Adj. Relative Risk (95% C.I.)[a]	p-Value[a]
		n in 1997	Number (%) Abnormal in 1997		
All	*Ranch Hand*	*727*	*50 (6.9)*	*0.97 (0.66,1.43)*	*0.894*
	Comparison	*933*	*66 (7.1)*		
Officer	Ranch Hand	277	22 (7.9)	1.07 (0.59,1.93)	0.821
	Comparison	366	27 (7.4)		
Enlisted Flyer	Ranch Hand	129	12 (9.3)	1.42 (0.58,3.52)	0.444
	Comparison	135	9 (6.7)		
Enlisted Groundcrew	Ranch Hand	321	16 (5.0)	0.73 (0.39,1.38)	0.335
	Comparison	432	30 (6.9)		

[a] Relative risk, confidence interval, and p-values are in reference to a contrast of 1985 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal dorsalis pedis pulses in 1985 (see Chapter 7, Statistical Methods).

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) Abnormal/(n) Examination		
	1985	1992	1997
Low	14 (9.4)	8 (5.6)	12 (8.1)
	(149)	(144)	(149)
Medium	20 (12.7)	14 (9.0)	16 (10.1)
	(158)	(155)	(158)
High	12 (7.8)	9 (6.0)	10 (6.5)
	(154)	(149)	(154)

Initial Dioxin Category Summary Statistics			Analysis Results for Log_2 (Initial Dioxin)[a]	
	Normal in 1985			
Initial Dioxin	n in 1997	Number (%) Abnormal in 1997	Adj. Relative Risk (95% C.I.)[b]	p-Value
Low	135	10 (7.4)	1.01 (0.72,1.41)	0.946
Medium	138	11 (8.0)		
High	142	7 (4.9)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal dorsalis pedis pulses in 1985 (see Chapter 7, Statistical Methods).

Table 14-35. Longitudinal Analysis of Dorsalis Pedis Pulses (Continued)

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

	Number (%) Abnormal/(n) Examination		
Dioxin Category	1985	1992	1997
Comparison	108 (10.6) (1,016)	70 (7.1) (991)	85 (8.4) (1,016)
Background RH	48 (13.5) (355)	29 (8.4) (345)	29 (8.2) (355)
Low RH	21 (9.4) (224)	12 (5.5) (217)	22 (9.8) (224)
High RH	25 (10.5) (237)	19 (8.2) (231)	16 (6.8) (237)
Low plus High RH	46 (10.0) (461)	31 (6.9) (448)	38 (8.2) (461)

	Normal in 1985			
Dioxin Category	n in 1997	Number (%) Abnormal in 1997	Adj. Relative Risk (95% C.I.)[a][b]	p-Value[b]
Comparison	908	66 (7.3)		
Background RH	307	22 (7.2)	0.89 (0.53,1.48)	0.650
Low RH	203	17 (8.4)	1.08 (0.61,1.89)	0.798
High RH	212	11 (5.2)	0.91 (0.47,1.78)	0.789
Low plus High RH	415	28 (6.7)	0.99 (0.62,1.59)	0.964

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.
　　　Comparison: 1987 Dioxin ≤ 10 ppt.
　　　Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
　　　Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
　　　High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin > 94 ppt.

　　　Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal dorsalis pedis pulses in 1985 (see Chapter 7, Statistical Methods).

14.2.3.1.6　Posterior Tibial Pulses

Model 1 and 2 analyses did not show any significant associations between dioxin and the change in posterior tibial pulses between 1985 and 1997 (Table 14-36(a,b): p>0.12 for each analysis).

Model 3 analysis of the change in posterior tibial pulses from normal in 1985 to abnormal in 1997 revealed one significant and one marginally significant contrast: Ranch Hands in the high dioxin category versus Comparisons (Table 14-36(c): Adj. RR=1.70, p=0.090) and Ranch Hands in the low plus high dioxin category versus Comparisons (Table 14-36(c): Adj. RR=1.60, p=0.047). Of the Comparisons, 5.1 percent had normal posterior tibial pulses in 1985 and abnormal posterior tibial pulses

in 1997. Of the Ranch Hands, 6.3 percent in the high dioxin category and 7.2 percent in the low plus high dioxin category had normal posterior tibial pulses in 1985 and abnormal posterior tibial pulses in 1997.

Table 14-36. Longitudinal Analysis of Posterior Tibial Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) Abnormal/(n) Examination		
		1985	1992	1997
All	*Ranch Hand*	*2 (0.2)* *(822)*	*20 (2.5)* *(801)*	*56 (6.8)* *(822)*
	Comparison	*6 (0.6)* *(1,044)*	*22 (2.2)* *(1,017)*	*58 (5.6)* *(1,044)*
Officer	Ranch Hand	1 (0.3) (318)	9 (2.9) (313)	21 (6.6) (318)
	Comparison	2 (0.5) (411)	10 (2.5) (404)	23 (5.6) (411)
Enlisted Flyer	Ranch Hand	1 (0.7) (145)	5 (3.5) (143)	14 (9.7) (145)
	Comparison	1 (0.6) (156)	4 (2.6) (154)	10 (6.4) (156)
Enlisted Groundcrew	Ranch Hand	0 (0.0) (359)	6 (1.7) (345)	21 (5.8) (359)
	Comparison	3 (0.6) (477)	8 (1.7) (459)	25 (5.2) (477)

Occupational Category	Group	Normal in 1985		Adj. Relative Risk (95% C.I.)[a]	p-Value[a]
		n in 1997	Number (%) Abnormal in 1997		
All	*Ranch Hand*	*820*	*56 (6.8)*	*1.36 (0.92,2.01)*	*0.129*
	Comparison	*1,038*	*53 (5.1)*		
Officer	Ranch Hand	317	21 (6.6)	1.29 (0.69,2.43)	0.423
	Comparison	409	21 (5.1)		
Enlisted Flyer	Ranch Hand	144	14 (9.7)	1.70 (0.70,4.09)	0.239
	Comparison	155	9 (5.8)		
Enlisted Groundcrew	Ranch Hand	359	21 (5.8)	1.26 (0.68,2.35)	0.458
	Comparison	474	23 (4.9)		

[a] Relative risk, confidence interval, and p-values are in reference to a contrast of 1985 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal posterior tibial pulses in 1985 (see Chapter 7, Statistical Methods).

Table 14-36. Longitudinal Analysis of Posterior Tibial Pulses (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) Abnormal/(n) Examination		
	1985	**1992**	**1997**
Low	1 (0.7) (149)	5 (3.5) (144)	9 (6.0) (149)
Medium	0 (0.0) (158)	5 (3.2) (155)	15 (9.5) (158)
High	1 (0.6) (155)	2 (1.3) (151)	9 (5.8) (155)

Initial Dioxin Category Summary Statistics			Analysis Results for Log$_2$ (Initial Dioxin)[a]	
	Normal in 1985			
Initial Dioxin	**n in 1997**	**Number (%) Abnormal in 1997**	**Adj. Relative Risk (95% C.I.)[b]**	**p-Value**
Low	148	9 (6.1)	1.12 (0.85,1.49)	0.418
Medium	158	15 (9.5)		
High	154	9 (5.8)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal posterior tibial pulses in 1985 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) Abnormal/(n) Examination		
	1985	**1992**	**1997**
Comparison	6 (0.6) (1,016)	22 (2.2) (991)	57 (5.6) (1,016)
Background RH	0 (0.0) (355)	7 (2.0) (346)	22 (6.2) (355)
Low RH	1 (0.4) (224)	6 (2.8) (217)	18 (8.0) (224)
High RH	1 (0.4) (238)	6 (2.6) (233)	15 (6.3) (238)
Low plus High RH	2 (0.4) (462)	12 (2.7) (450)	33 (7.1) (462)

Table 14-36. Longitudinal Analysis of Posterior Tibial Pulses (Continued)

Dioxin Category	n in 1997	Number (%) Abnormal in 1997	Adj. Relative Risk (95% C.I.)[a][b]	p-Value[b]
		Normal in 1985		
Comparison	1,010	52 (5.1)		
Background RH	355	22 (6.2)	1.05 (0.62,1.77)	0.856
Low RH	223	18 (8.1)	1.50 (0.85,2.65)	0.160
High RH	237	15 (6.3)	1.70 (0.92,3.12)	0.090
Low plus High RH	460	33 (7.2)	1.60 (1.01,2.54)	0.047

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.
  Comparison: 1987 Dioxin ≤ 10 ppt.
  Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
  Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
  High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin > 94 ppt.

  Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal posterior tibial pulses in 1985 (see Chapter 7, Statistical Methods).

14.2.3.1.7   Leg Pulses

The longitudinal analyses in Models 1 through 3 did not reveal a significant association between dioxin and the change from normal leg pulses in 1985 to abnormal leg pulses in 1997 (Table 14-37(a–c): p>0.15 for each analysis).

Table 14-37. Longitudinal Analysis of Leg Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) Abnormal/(n) Examination		
		1985	1992	1997
All	*Ranch Hand*	*97 (11.8)* *(821)*	*66 (8.3)* *(798)*	*91 (11.1)* *(821)*
	Comparison	*114 (10.9)* *(1,042)*	*77 (7.6)* *(1,015)*	*109 (10.5)* *(1,042)*
Officer	Ranch Hand	43 (13.5) (318)	24 (7.7) (312)	35 (11.0) (318)
	Comparison	44 (10.8) (409)	29 (7.2) (402)	38 (9.3) (409)
Enlisted Flyer	Ranch Hand	17 (11.7) (145)	11 (7.7) (143)	25 (17.2) (145)
	Comparison	22 (14.1) (156)	16 (10.4) (154)	17 (10.9) (156)
Enlisted Groundcrew	Ranch Hand	37 (10.3) (358)	31 (9.0) (343)	31 (8.7) (358)
	Comparison	48 (10.1) (477)	32 (7.0) (459)	54 (11.3) (477)

Table 14-37. Longitudinal Analysis of Leg Pulses (Continued)

Occupational Category	Group	Normal in 1985		Adj. Relative Risk (95% C.I.)[a]	p-Value[a]
		n in 1997	Number (%) Abnormal in 1997		
All	*Ranch Hand*	*724*	*73 (10.1)*	*1.12 (0.80,1.57)*	*0.502*
	Comparison	*928*	*85 (9.2)*		
Officer	Ranch Hand	275	29 (10.5)	1.13 (0.67,1.93)	0.645
	Comparison	365	34 (9.3)		
Enlisted Flyer	Ranch Hand	128	19 (14.8)	1.76 (0.81,3.83)	0.153
	Comparison	134	12 (9.0)		
Enlisted Groundcrew	Ranch Hand	321	25 (7.8)	0.89 (0.52,1.52)	0.676
	Comparison	429	39 (9.1)		

[a] Relative risk, confidence interval, and p-values are in reference to a contrast of 1985 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal leg pulses in 1985 (see Chapter 7, Statistical Methods).

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

Initial Dioxin	Number (%) Abnormal/(n) Examination		
	1985	1992	1997
Low	15 (10.1)	9 (6.3)	15 (10.1)
	(149)	(144)	(149)
Medium	20 (12.7)	17 (11.0)	22 (13.9)
	(158)	(155)	(158)
High	13 (8.4)	9 (6.0)	14 (9.1)
	(154)	(149)	(154)

Initial Dioxin Category Summary Statistics			Analysis Results for Log$_2$ (Initial Dioxin)[a]	
	Normal in 1985			
Initial Dioxin	n in 1997	Number (%) Abnormal in 1997	Adj. Relative Risk (95% C.I.)[b]	p-Value
Low	134	13 (9.7)	1.14 (0.87,1.49)	0.344
Medium	138	17 (12.3)		
High	141	11 (7.8)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal leg pulses in 1985 (see Chapter 7, Statistical Methods).

Table 14-37. Longitudinal Analysis of Leg Pulses (Continued)

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

Dioxin Category	Number (%) Abnormal/(n) Examination		
	1985	**1992**	**1997**
Comparison	111 (10.9) (1,014)	77 (7.8) (989)	108 (10.7) (1,014)
Background RH	49 (13.8) (355)	30 (8.7) (345)	39 (11.0) (355)
Low RH	22 (9.8) (224)	13 (6.0) (217)	29 (12.9) (224)
High RH	26 (11.0) (237)	22 (9.5) (231)	22 (9.3) (237)
Low plus High RH	48 (10.4) (461)	35 (7.8) (448)	51 (11.1) (461)

Dioxin Category	Normal in 1985		Adj. Relative Risk (95% C.I.)[ab]	p-Value[b]
	n in 1997	**Number (%) Abnormal in 1997**		
Comparison	903	84 (9.3)		
Background RH	306	31 (10.1)	0.98 (0.63,1.52)	0.924
Low RH	202	24 (11.9)	1.21 (0.74,1.97)	0.455
High RH	211	17 (8.1)	1.17 (0.67,2.04)	0.589
Low plus High RH	413	41 (9.9)	1.19 (0.79,1.78)	0.411

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin > 94 ppt.

Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal leg pulses in 1985 (see Chapter 7, Statistical Methods).

14.2.3.1.8 Peripheral Pulses

The change from normal peripheral pulses in 1985 to abnormal peripheral pulses in 1997 was not significantly associated with dioxin in Models 1 through 3 (Table 14-38(a–c): p>0.15 for each analysis).

Table 14-38. Longitudinal Analysis of Peripheral Pulses

(a) MODEL 1: RANCH HANDS VS. COMPARISONS

Occupational Category	Group	Number (%) Abnormal/(n) Examination		
		1985	1992	1997
All	*Ranch Hand*	*97 (11.8)* *(821)*	*66 (8.3)* *(798)*	*94 (11.4)* *(821)*
	Comparison	*116 (11.1)* *(1,041)*	*81 (8.0)* *(1,014)*	*112 (10.8)* *(1,041)*
Officer	Ranch Hand	43 (13.5) (318)	24 (7.7) (312)	36 (11.3) (318)
	Comparison	44 (10.8) (409)	30 (7.5) (402)	40 (9.8) (409)
Enlisted Flyer	Ranch Hand	17 (11.7) (145)	11 (7.7) (143)	25 (17.2) (145)
	Comparison	22 (14.1) (156)	16 (10.4) (154)	17 (10.9) (156)
Enlisted Groundcrew	Ranch Hand	37 (10.3) (358)	31 (9.0) (343)	33 (9.2) (358)
	Comparison	50 (10.5) (476)	35 (7.6) (458)	55 (11.6) (476)

Occupational Category	Group	Normal in 1985		Adj. Relative Risk (95% C.I.)[a]	p-Value[a]
		n in 1997	Number (%) Abnormal in 1997		
All	*Ranch Hand*	*724*	*76 (10.5)*	*1.14 (0.82,1.59)*	*0.433*
	Comparison	*925*	*87 (9.4)*		
Officer	Ranch Hand	275	30 (10.9)	1.10 (0.66,1.86)	0.710
	Comparison	365	36 (9.9)		
Enlisted Flyer	Ranch Hand	128	19 (14.8)	1.76 (0.81,3.83)	0.154
	Comparison	134	12 (9.0)		
Enlisted Groundcrew	Ranch Hand	321	27 (8.4)	0.97 (0.57,1.64)	0.901
	Comparison	426	39 (9.2)		

[a] Relative risk, confidence interval, and p-values are in reference to a contrast of 1985 and 1997 results; results adjusted for age in 1997.

Note: Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal peripheral pulses in 1985 (see Chapter 7, Statistical Methods).

Table 14-38. Longitudinal Analysis of Peripheral Pulses (Continued)

(b) MODEL 2: RANCH HANDS — INITIAL DIOXIN

| Initial Dioxin | Number (%) Abnormal/(n) Examination | | |
	1985	1992	1997
Low	15 (10.1) (149)	9 (6.3) (144)	16 (10.7) (149)
Medium	20 (12.7) (158)	17 (11.0) (155)	22 (13.9) (158)
High	13 (8.4) (154)	9 (6.0) (149)	15 (9.7) (154)

| Initial Dioxin Category Summary Statistics | | | Analysis Results for Log_2 (Initial Dioxin)[a] | |
| | Normal in 1985 | | | |
Initial Dioxin	n in 1997	Number (%) Abnormal in 1997	Adj. Relative Risk (95% C.I.)[b]	p-Value
Low	134	14 (10.4)	1.11 (0.85,1.45)	0.434
Medium	138	17 (12.3)		
High	141	12 (8.5)		

[a] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.
[b] Relative risk for a twofold increase in initial dioxin.

Note: Low = 27–63 ppt; Medium = >63–152 ppt; High = >152 ppt.

Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal peripheral pulses in 1985 (see Chapter 7, Statistical Methods).

(c) MODEL 3: RANCH HANDS AND COMPARISONS BY DIOXIN CATEGORY

| Dioxin Category | Number (%) Abnormal/(n) Examination | | |
	1985	1992	1997
Comparison	113 (11.2) (1,013)	81 (8.2) (988)	111 (11.0) (1,013)
Background RH	49 (13.8) (355)	30 (8.7) (345)	40 (11.3) (355)
Low RH	22 (9.8) (224)	13 (6.0) (217)	30 (13.4) (224)
High RH	26 (11.0) (237)	22 (9.5) (231)	23 (9.7) (237)
Low plus High RH	48 (10.4) (461)	35 (7.8) (448)	53 (11.5) (461)

Table 14-38. Longitudinal Analysis of Peripheral Pulses (Continued)

Dioxin Category	Normal in 1985		Adj. Relative Risk (95% C.I.)[ab]	p-Value[b]
	n in 1997	Number (%) Abnormal in 1997		
Comparison	900	86 (9.6)		
Background RH	306	32 (10.5)	0.98 (0.63,1.52)	0.934
Low RH	202	25 (12.4)	1.23 (0.76,1.99)	0.408
High RH	211	18 (8.5)	1.22 (0.70,2.11)	0.482
Low plus High RH	413	43 (10.4)	1.22 (0.82,1.82)	0.325

[a] Relative risk and confidence interval relative to Comparisons.
[b] Adjusted for percent body fat at the time of the blood measurement of dioxin and age in 1997.

Note: RH = Ranch Hand.
Comparison: 1987 Dioxin ≤ 10 ppt.
Background (Ranch Hand): 1987 Dioxin ≤ 10 ppt.
Low (Ranch Hand): 1987 Dioxin >10 ppt, 10 ppt < Initial Dioxin ≤ 94 ppt.
High (Ranch Hand): 1987 Dioxin >10 ppt, Initial Dioxin > 94 ppt.

Summary statistics for 1992 are provided for reference purposes for participants who attended the 1985 and 1997 examinations. Statistical analyses are based only on participants who had normal peripheral pulses in 1985 (see Chapter 7, Statistical Methods).

14.3   DISCUSSION

Cardiovascular diseases are among the most common encountered by the primary care physician. In practice, the diagnosis of cardiovascular disease is based primarily on the noninvasive data analyzed in the current chapter. Specifically, the history, physical examination, chest x ray, and resting ECG remain highly reliable indices that can alert the clinician to the presence of underlying cardiovascular disease and indicate the need for additional, more specific, noninvasive or invasive studies. Although arbitrary, dividing data collection into central and peripheral cardiovascular functions is convenient and forms a reasonable basis for comparison of the cohorts under study.

The limitations of the history in cardiovascular diagnosis deserve emphasis. In peripheral vascular disease, for example, signs and symptoms will vary depending on the degree of development of collateral circulatory channels. While hemodynamically significant arterial disease of the lower extremities is usually associated with claudication, severe carotid occlusive disease can be present in the absence of symptoms of transient cerebral ischemia. Further, conclusive evidence shows that advanced coronary artery disease can occur in the absence of angina and be present as "silent" myocardial ischemia. Lastly, it is well recognized that the cardiovascular history, as related by patients, is often subject to error. The generic term "heart attack," for example, can be used to describe any type of cardiac event from an isolated episode of unstable angina or arrhythmia to a myocardial infarction. These imperfections highlight the importance of the medical record verification conducted in this study.

In the cardiovascular assessment particularly, the physical examination can provide valuable clues to the presence of asymptomatic but significant underlying disease. Steps were taken to simplify data collection and reduce differences among the examining physicians. All blood pressure readings, for example, were taken by automated sphygmomanometric instruments. Auscultory endpoints—murmurs and bruits— were recorded as present or absent by anatomic location, thus eliminating speculation as to specific

valvular or vessel origin and hemodynamic significance. As markers of occult arterial occlusive disease, vascular bruits are relatively easy to detect and were carefully sought over the carotid, abdominal, and femoral vessels.

The data relevant to this chapter included the resting ECG, the standard two-view chest x ray (discussed in Chapter 18, Pulmonary Assessment) and Doppler arterial vascular studies. The test used can confirm diagnoses that can be made based on data available in the current assessment. For example, when correlated with the history and physical examination, the chest x ray and ECG enable the clinician to draw highly accurate conclusions regarding the presence and hemodynamic significance of valvular heart disease of any etiology. As defined by the chest x ray, the pulmonary vascularity can provide reliable clues to the presence of global left ventricular dysfunction with pulmonary venous congestion and of pulmonary hypertension of any cause.

In the analyses of verified historical variables, hypertension, myocardial infarction, transient ischemic attack, and stroke were similar in Ranch Hands and Comparisons. In the 1997 examinations, in contrast to 1992, Ranch Hands were more likely to have a history of heart disease (66.1% vs. 60.8%) across all occupational strata, particularly in the enlisted flyer category. In none of the physical examination or electrocardiographic variables were any significant group differences defined. The prevalence of funduscopic abnormalities, peripheral pulse deficits, and intermittent claudication, all more common in Ranch Hands than Comparisons in the 1992 examination, is now essentially the same in the two cohorts.

Serum dioxin analyses yielded several significant results. In the unadjusted analysis, a significant positive dose-response effect was noted in Ranch Hands in the association of hypertension with 1987 serum dioxin levels (34.0%, 38.0%, and 49.1% in the low, medium, and high categories, respectively), an association that remained significant after adjustment for covariates. Similarly, although the association was less significant, a positive dose-response effect was noted between the electrocardiographic evidence of a myocardial infarction and both initial and 1987 serum dioxin levels. Ranch Hands in the highest dioxin category were more likely than Comparisons to have tachycardia, as determined by the electrocardiograph. In contrast, although Ranch Hands were more likely than Comparisons to have a history of heart disease, a significant inverse dose-response effect was noted in relation to both extrapolated initial and 1987 serum dioxin levels. These results are consistent with those from both the 1987 and 1992 examinations.

With few exceptions, dependent variable-covariate analyses confirmed well-established associations. By a medical records review and by abnormalities detected on physical examinations, cardiovascular disease was associated significantly with the classic risk factors of age, cigarette use, and, particularly, diabetes. Obesity proved to be a significant risk factor for the development of heart disease and for numerous electrocardiographic abnormalities but not to the occurrence of myocardial infarction historically or by ECG. Alcohol consumption was associated strongly with the development of hypertension but did not have the protective effect on the occurrence of myocardial infarction that was noted in the 1992 examination. The increased prevalence of pulse deficits in association with alcohol consumption may have been mediated by concomitant cigarette use. Finally, consistent with the results of the 1987 and 1992 examinations, type A personality traits were not found to be associated with an increased risk for the development of cardiovascular disease.

In the longitudinal analysis, a comparable increase in the prevalence of peripheral pulse deficits was noted in both the Ranch Hand and Comparison cohorts between the 1992 and 1997 examinations. Although none of the group differences was statistically significant, Ranch Hands continued to have a slightly greater prevalence of pulse deficits than Comparisons at all sites examined. Two of the six analyses, the posterior tibial and femoral pulses, yielded evidence for a significant or marginally significant association

of pulse deficits with categorized dioxin. Consistent with all previous examinations, Comparisons were found to be at slightly greater risk than Ranch Hands for the development of systolic hypertension by discrete analysis, but group differences remain nonsignificant.

In contrast to prior examinations, the current study has documented that Ranch Hands are more likely than Comparisons to have historical evidence for heart disease (excluding essential hypertension) but are no longer at greater risk for the occurrence of pulse deficits. By all other indices, the prevalence of cardiovascular disease appears similar in both cohorts. For the first time, there is evidence that dioxin exposure may be a risk factor for the development of hypertension and myocardial infarction. As of 1997, the verified history of essential hypertension was associated with 1987 dioxin, and the evidence of prior myocardial infarction from the ECG was associated with initial dioxin.

14.4 SUMMARY

The cardiovascular assessment was based on a medical records review and verification, physical examination and ECG determinations, and an ICVI index based on participant responses to three questions regarding leg pain. Variables constructed from the medical records review included essential hypertension, heart disease (excluding essential hypertension), myocardial infarction, and stroke or transient ischemic attack. The physical examination findings, the ECG determinations, and the ICVI index investigated the central cardiac function and peripheral vascular function. Each health endpoint was examined for an association with exposure group (Model 1), initial dioxin (Model 2), categorized dioxin (Model 3), and 1987 dioxin levels (Model 4). Significant results from the adjusted analyses are presented below.

14.4.1 Model 1: Group Analysis

The adjusted group analysis revealed that Ranch Hands had a significantly higher percentage of participants with a history of heart disease (excluding essential hypertension) than did Comparisons when all occupational strata were combined. Stratifying by occupation revealed a significantly higher percentage of Ranch Hand enlisted flyers with a history of heart disease than Comparison enlisted flyers. Ranch Hand enlisted groundcrew had a significantly lower percentage of abnormal funduscopic examination results than Comparison enlisted groundcrew. Ranch Hand enlisted groundcrew also had a marginally significantly lower percentage of abnormal overall ECG findings than Comparison enlisted groundcrew. The results of all unadjusted and adjusted Model 1 analyses are summarized in Table 14-39.

Table 14-39. Summary of Group Analysis (Model 1) for Cardiovascular Variables (Ranch Hands vs. Comparisons)

	UNADJUSTED			
Variable	**All**	**Officer**	**Enlisted Flyer**	**Enlisted Groundcrew**
Medical Records				
Essential Hypertension (D)	ns	ns	NS	ns
Heart Disease (Excluding Essential Hypertension) (D)	+0.013	NS	+0.003	NS
Myocardial Infarction (D)	NS	ns	NS	NS
Stroke or Transient Ischemic Attack (D)	NS	NS	ns	NS
Physical Examination				
Systolic Blood Pressure (C)	ns	ns	ns	ns
Systolic Blood Pressure (D)	ns	NS	NS	ns

Table 14-39. *Summary of Group Analysis (Model 1) for Cardiovascular Variables (Ranch Hands vs. Comparisons) (Continued)*

Variable	UNADJUSTED			
	All	Officer	Enlisted Flyer	Enlisted Groundcrew
Diastolic Blood Pressure (C)	ns	ns	NS	ns
Diastolic Blood Pressure (D)	NS	NS	NS	ns
Heart Sounds (D)	ns	ns	ns	ns
Overall Electrocardiograph (ECG) (D)	NS	NS	NS	ns*
ECG: Right Bundle Branch Block (D)	ns	ns	NS	ns
ECG: Left Bundle Branch Block (D)	ns	ns	NS	ns
ECG: Non-Specific ST- and T-Wave Changes (D)	NS	NS	NS	ns
ECG: Bradycardia (D)	ns	ns	NS	ns
ECG: Tachycardia (D)	NS	NS	NS	NS
ECG: Arrhythmia (D)	NS	NS	NS	ns
ECG: Evidence of Prior Myocardial Infarction (D)	ns	ns	ns	ns
ECG: Other Diagnoses (D)	NS	NS	--	NS
Funduscopic Examination (D)	ns	NS	NS	−0.033
Carotid Bruits (D)	NS	ns	NS	ns
Radial Pulses (D)	NS	NS	--	NS
Femoral Pulses (D)	NS*	NS	NS	NS
Popliteal Pulses (D)	NS	ns	NS	NS
Dorsalis Pedis Pulses (D)	NS	NS	NS	ns
Posterior Tibial Pulses (D)	NS	NS	NS	NS
Leg Pulses (D)	NS	NS	NS	ns
Peripheral Pulses (D)	NS	NS	NS	ns
Self-reported Questionnaire				
Intermittent Claudication and Vascular Insufficiency Index (ICVI) (D)	NS	NS	ns	NS

Note: NS or ns: Not significant (p>0.10).

      NS* or ns*: Marginally significant (0.05<p≤0.10).

      C: Continuous analysis.

      D: Discrete analysis.

      +: Relative risk ≥1.00.

      −: Relative risk <1.00.

      --: Analysis not performed because of the sparse number of participants with an abnormality.

P-value given if p≤0.05.

A capital "NS" denotes a relative risk of 1.00 or greater for discrete analysis or differences of means nonnegative for continuous analysis. A lowercase "ns" denotes a relative risk less than 1.00 for discrete analysis or difference of means negative for continuous analysis.

Variable	ADJUSTED			
	All	Officer	Enlisted Flyer	Enlisted Groundcrew
Medical Records				
Essential Hypertension (D)	ns	ns	NS	ns
Heart Disease (Excluding Essential Hypertension) (D)	+0.018	NS	+0.004	NS
Myocardial Infarction (D)	NS	ns	NS	ns
Stroke or Transient Ischemic Attack (D)	NS	NS	--	NS
Physical Examination				
Systolic Blood Pressure (C)	ns	ns	NS	ns
Systolic Blood Pressure (D)	ns	ns	NS	ns
Diastolic Blood Pressure (C)	NS	ns	NS	NS
Diastolic Blood Pressure (D)	NS	NS	NS	ns
Heart Sounds (D)	ns	ns	ns	ns
Overall Electrocardiograph (ECG) (D)	ns	NS	NS	ns*
ECG: Right Bundle Branch Block (D)	ns	ns	NS	ns
ECG: Left Bundle Branch Block (D)	ns	ns	--	ns
ECG: Non-Specific ST- and T-Wave Changes (D)	NS	NS	NS	ns
ECG: Bradycardia (D)	ns	ns	NS	ns
ECG: Tachycardia (D)	NS	--	--	NS
ECG: Arrhythmia (D)	NS	NS	NS	ns
ECG: Evidence of Prior Myocardial Infarction (D)	ns	ns	NS	ns
ECG: Other Diagnoses (D)	NS	--	--	NS
Funduscopic Examination (D)	ns	NS	NS	−0.047
Carotid Bruits (D)	ns	ns	NS	ns
Radial Pulses (D)	NS	NS	--	NS
Femoral Pulses (D)	NS	NS	NS	NS
Popliteal Pulses (D)	NS	ns	ns	NS
Dorsalis Pedis Pulses (D)	ns	NS	NS	ns
Posterior Tibial Pulses (D)	NS	NS	NS	NS
Leg Pulses (D)	NS	NS	NS	ns
Peripheral Pulses (D)	NS	NS	NS	ns
Self-reported Questionnaire				
Intermittent Claudication and Vascular Insufficiency Index (ICVI) (D)	ns	NS	ns	NS

Note: NS or ns: Not significant (p>0.10).

    ns*: Marginally significant (0.05<p≤0.10).

    C: Continuous analysis.

    D: Discrete analysis.

    +: Relative risk ≥1.00.

    −: Relative risk <1.00.

    --: Analysis not performed because of the sparse number of participants with an abnormality.

    P-value given if p≤0.05.

    A capital "NS" denotes a relative risk of 1.00 or greater for discrete analysis or differences of means nonnegative for continuous analysis. A lowercase "ns" denotes a relative risk less than 1.00 for discrete analysis or difference of means negative for continuous analysis.

14.4.2   Model 2: Initial Dioxin Analysis

Model 2 analyses revealed a significant positive association between initial dioxin and evidence of prior myocardial infarction from the ECG. The results of all unadjusted and adjusted Model 2 analyses are summarized in Table 14-40.

Table 14-40. Summary of Initial Dioxin Analysis (Model 2) for Cardiovascular Variables (Ranch Hands Only)

Variable	Unadjusted	Adjusted
Medical Records		
Essential Hypertension (D)	NS	NS
Heart Disease (Excluding Essential Hypertension) (D)	−0.001	ns
Myocardial Infarction (D)	NS	NS
Stroke or Transient Ischemic Attack (D)	NS	NS
Physical Examination		
Systolic Blood Pressure (C)	ns	ns
Systolic Blood Pressure (D)	−0.031	ns
Diastolic Blood Pressure (C)	NS	NS
Diastolic Blood Pressure (D)	NS	NS
Heart Sounds (D)	NS	NS
Overall Electrocardiograph (ECG) (D)	ns	NS
ECG: Right Bundle Branch Block (D)	ns	NS
ECG: Left Bundle Branch Block (D)	ns	--
ECG: Non-Specific ST- and T-Wave Changes (D)	ns	NS
ECG: Bradycardia (D)	ns	ns
ECG: Tachycardia (D)	NS	--
ECG: Arrhythmia (D)	ns	NS
ECG: Evidence of Prior Myocardial Infarction (D)	NS	+0.012
ECG: Other Diagnoses (D)	NS	--
Funduscopic Examination (D)	ns	NS
Carotid Bruits (D)	NS	NS
Radial Pulses (D)	ns	--
Femoral Pulses (D)	ns	NS
Popliteal Pulses (D)	ns	ns
Dorsalis Pedis Pulses (D)	ns	NS
Posterior Tibial Pulses (D)	NS	NS
Leg Pulses (D)	ns	NS
Peripheral Pulses (D)	ns	NS
Self-reported Questionnaire		
Intermittent Claudication and Vascular Insufficiency Index (ICVI) (D)	ns	NS

Note: NS or ns: Not significant (p>0.10).

     C: Continuous analysis.

     D: Discrete analysis.

     +: Relative risk ≥1.00.

     −: Relative risk <1.00.

     --: Analysis not performed because of the sparse number of Ranch Hands with an abnormality.

     P-value given if p≤0.05.

     A capital "NS" denotes a relative risk of 1.00 or greater for discrete analysis or slope nonnegative for continuous analysis. A lowercase "ns" denotes a relative risk less than 1.00 for discrete analysis or slope negative for continuous analysis.

14.4.3 Model 3: Categorized Dioxin Analysis

The adjusted Model 3 analysis revealed a significantly higher occurrence of heart disease for Ranch Hands in the background dioxin category than for Comparisons. A significantly lower prevalence of abnormal heart sounds was found for Ranch Hands in the background dioxin category than for Comparisons. The percentage of Ranch Hands in the low dioxin category with a history of heart disease was marginally significantly greater than Comparisons. The prevalence of Ranch Hands in the low dioxin category with abnormal ECG findings was marginally significantly smaller than Comparisons. Ranch Hands in the high dioxin category had a significantly greater prevalence of tachycardia and other ECG diagnoses than Comparisons. The results of all unadjusted and adjusted Model 3 analyses are summarized in Table 14-41.

Table 14-41. Summary of Categorized Dioxin Analysis (Model 3) for Cardiovascular Variables (Ranch Hands vs. Comparisons)

| | UNADJUSTED | | | |
Variable	Background Ranch Hands vs. Comparisons	Low Ranch Hands vs. Comparisons	High Ranch Hands vs. Comparisons	Low plus High Ranch Hands vs. Comparisons
Medical Records				
Essential Hypertension (D)	ns	ns	NS	NS
Heart Disease (Excluding Essential Hypertension) (D)	+0.005	+0.011	ns	NS
Myocardial Infarction (D)	ns	ns	NS	NS
Stroke or Transient Ischemic Attack (D)	NS	ns	NS	ns
Physical Examination				
Systolic Blood Pressure (C)	ns	NS	ns*	ns
Systolic Blood Pressure (D)	NS	NS	ns	ns
Diastolic Blood Pressure (C)	ns	ns	NS*	NS
Diastolic Blood Pressure (D)	ns	NS	NS	NS
Heart Sounds (D)	−0.047	ns	ns	ns
Overall Electrocardiograph (ECG) (D)	NS	ns	ns	ns
ECG: Right Bundle Branch Block (D)	ns	ns	NS	ns
ECG: Left Bundle Branch Block (D)	NS	ns	ns	ns
ECG: Non-Specific ST- and T-Wave Changes (D)	ns	NS	NS	NS
ECG: Bradycardia (D)	ns	ns	−0.042	−0.020
ECG: Tachycardia (D)	NS	ns	+0.033	NS
ECG: Arrhythmia (D)	ns	NS	ns	NS
ECG: Evidence of Prior Myocardial Infarction (D)	ns	NS	ns	ns
ECG: Other Diagnoses (D)	NS	ns	+0.042	NS
Funduscopic Examination (D)	ns	NS	ns	NS
Carotid Bruits (D)	ns	ns	NS	NS
Radial Pulses (D)	NS	NS	NS	NS
Femoral Pulses (D)	NS	NS	NS	NS*
Popliteal Pulses (D)	ns	NS	NS	NS
Dorsalis Pedis Pulses (D)	ns	NS	ns	NS
Posterior Tibial Pulses (D)	NS	NS	NS	NS
Leg Pulses (D)	ns	NS	NS	NS
Peripheral Pulses (D)	ns	NS	NS	NS

Table 14-41. Summary of Categorized Dioxin Analysis (Model 3) for Cardiovascular Variables (Ranch Hands vs. Comparisons) (Continued)

Variable	UNADJUSTED			
	Background Ranch Hands vs. Comparisons	Low Ranch Hands vs. Comparisons	High Ranch Hands vs. Comparisons	Low plus High Ranch Hands vs. Comparisons
Self-reported Questionnaire				
Intermittent Claudication and Vascular Insufficiency Index (ICVI) (D)	ns	NS	NS	NS

Note: NS or ns: Not significant (p>0.10).

      NS* or ns*: Marginally significant (0.05<p≤0.10).

      C: Continuous analysis.

      D: Discrete analysis.

      +: Relative risk ≥1.00.

      −: Relative risk <1.00.

      P-value given if p≤0.05.

      A capital "NS" denotes a relative risk of 1.00 or greater for discrete analysis or differences of means nonnegative for continuous analysis. A lowercase "ns" denotes a relative risk less than 1.00 for discrete analysis or difference of means negative for continuous analysis.

Variable	ADJUSTED			
	Background Ranch Hands vs. Comparisons	Low Ranch Hands vs. Comparisons	High Ranch Hands vs. Comparisons	Low plus High Ranch Hands vs. Comparisons
Medical Records				
Essential Hypertension (D)	ns	ns	NS	NS
Heart Disease (Excluding Essential Hypertension) (D)	+0.032	NS*	NS	NS
Myocardial Infarction (D)	ns	ns	NS	NS
Stroke or Transient Ischemic Attack (D)	ns	ns	NS	NS
Physical Examination				
Systolic Blood Pressure (C)	NS	ns	ns	ns
Systolic Blood Pressure (D)	NS	NS	ns	ns
Diastolic Blood Pressure (C)	ns	ns	NS	NS
Diastolic Blood Pressure (D)	ns	ns	NS	NS
Heart Sounds (D)	−0.041	ns	NS	ns
Overall Electrocardiograph (ECG) (D)	NS	ns*	NS	ns
ECG: Right Bundle Branch Block (D)	NS	ns	NS	ns
ECG: Left Bundle Branch Block (D)	ns	ns	--	--
ECG: Non-Specific ST- and T-Wave Changes (D)	ns	ns	NS	NS
ECG: Bradycardia (D)	ns	ns	ns	ns*
ECG: Tachycardia (D)	NS	--	+0.032	--
ECG: Arrhythmia (D)	ns	NS	NS	NS
ECG: Evidence of Prior Myocardial Infarction (D)	ns	ns	NS	ns
ECG: Other Diagnoses (D)	NS	--	+0.050	--
Funduscopic Examination (D)	NS	ns	ns	ns
Carotid Bruits (D)	NS	ns	NS	ns
Radial Pulses (D)	NS	NS	NS	NS
Femoral Pulses (D)	NS	NS	NS	NS

	ADJUSTED			
Variable	Background Ranch Hands vs. Comparisons	Low Ranch Hands vs. Comparisons	High Ranch Hands vs. Comparisons	Low plus High Ranch Hands vs. Comparisons
Popliteal Pulses (D)	ns	NS	NS	NS
Dorsalis Pedis Pulses (D)	ns	ns	ns	ns
Posterior Tibial Pulses (D)	NS	NS	NS	NS
Leg Pulses (D)	NS	NS	ns	ns
Peripheral Pulses (D)	NS	NS	ns	NS
Self-reported Questionnaire				
Intermittent Claudication and Vascular Insufficiency Index (ICVI) (D)	ns	ns	NS	NS

Note: NS or ns: Not significant (p>0.10).

NS* or ns*: Marginally significant (0.05<p≤0.10).

C: Continuous analysis.

D: Discrete analysis.

+: Relative risk ≥1.00.

−: Relative risk <1.00.

--: Analysis not performed because of the sparse number of participants with an abnormality.

P-value given if p≤0.05.

A capital "NS" denotes a relative risk of 1.00 or greater for discrete analysis or differences of means nonnegative for continuous analysis. A lowercase "ns" denotes a relative risk less than 1.00 for discrete analysis or difference of means negative for continuous analysis.

14.4.4   Model 4: 1987 Dioxin Level Analysis

The adjusted Model 4 analysis revealed a significant positive association between essential hypertension and 1987 dioxin. A marginally significant association between the evidence of a prior myocardial infarction, as determined from the ECG, and 1987 dioxin also was observed. The results of all unadjusted and adjusted Model 4 analyses are summarized in Table 14-42.

Table 14-42. Summary of 1987 Dioxin Analysis (Model 4) for Cardiovascular Variables (Ranch Hands Only)

Variable	Unadjusted	Adjusted
Medical Records		
Essential Hypertension (D)	+<0.001	+0.011
Heart Disease (Excluding Essential Hypertension) (D)	−0.004	ns
Myocardial Infarction (D)	NS	NS
Stroke or Transient Ischemic Attack (D)	ns	NS
Physical Examination		
Systolic Blood Pressure (C)	NS	ns
Systolic Blood Pressure (D)	NS	ns*
Diastolic Blood Pressure (C)	+0.014	NS
Diastolic Blood Pressure (D)	NS	NS

Table 14-42. Summary of 1987 Dioxin Analysis (Model 4) for Cardiovascular Variables (Ranch Hands Only) (Continued)

Variable	Unadjusted	Adjusted
Heart Sounds (D)	NS	NS
Overall Electrocardiograph (ECG) (D)	ns	NS
ECG: Right Bundle Branch Block (D)	NS	NS
ECG: Left Bundle Branch Block (D)	ns	ns
ECG: Non-Specific ST- and T-Wave Changes (D)	NS	NS
ECG: Bradycardia (D)	ns*	ns
ECG: Tachycardia (D)	NS	NS
ECG: Arrhythmia (D)	ns	NS
ECG: Evidence of Prior Myocardial Infarction (D)	NS	NS*
ECG: Other Diagnoses (D)	NS	NS
Funduscopic Examination (D)	NS	NS
Carotid Bruits (D)	NS	ns
Radial Pulses (D)	ns	ns
Femoral Pulses (D)	NS	NS
Popliteal Pulses (D)	ns	NS
Dorsalis Pedis Pulses (D)	ns	NS
Posterior Tibial Pulses (D)	NS	NS
Leg Pulses (D)	NS	NS
Peripheral Pulses (D)	NS	NS
Self-reported Questionnaire		
Intermittent Claudication and Vascular Insufficiency Index (ICVI) (D)	NS	NS

Note: NS or ns: Not significant (p>0.10).

NS* or ns*: Marginally significant (0.05<p≤0.10).

C: Continuous analysis.

D: Discrete analysis.

+: Relative risk ≥1.00 for discrete analysis; slope nonnegative for continuous analysis.

−: Relative risk <1.00.

P-value given if p≤0.05.

A capital "NS" denotes a relative risk of 1.00 or greater for discrete analysis or slope nonnegative for continuous analysis. A lowercase "ns" denotes a relative risk less than 1.00 for discrete analysis or slope negative for continuous analysis.

14.5 CONCLUSION

Analyses revealed that Ranch Hands had a significantly higher percentage of participants with a history of heart disease (excluding essential hypertension) than did Comparisons and, in particular, within enlisted flyers. However, the risk of disease was not significantly increased in Ranch Hand enlisted groundcrew—the military occupation with the highest dioxin levels. The association between heart disease and initial dioxin for Ranch Hands showed a negative dose-response trend, with heart disease decreasing as initial dioxin increased. Furthermore, Ranch Hands in the background and the low dioxin categories had more heart disease than did Comparisons, but this increase was not seen in Ranch Hands in the high dioxin category. Increases in tachycardia and other ECG findings, such as pre-excitation, were seen for Ranch Hands in the high dioxin category, although the analyses were based on a sparse number of abnormalities. A significant positive association between initial dioxin and evidence of prior myocardial infarction from the ECG was observed in Ranch Hands, and a marginally significant positive

association was observed between 1987 dioxin and evidence of prior myocardial infarction from the ECG. A positive association between 1987 dioxin and essential hypertension also was observed in Ranch Hands. In contrast to previous AFHS examinations, no relation was found between peripheral pulses and any measures of exposure.

In summary, in contrast to prior examinations, the current study has documented that Ranch Hands are more likely than Comparisons to have historical evidence for heart disease (excluding essential hypertension) but are no longer at greater risk for the occurrence of pulse deficits. By all other indices, the prevalence of cardiovascular disease appears similar in both cohorts. For the first time, there is evidence that levels of dioxin may be a risk factor for the development of essential hypertension and prior myocardial infarction as indicated by interpretation of the ECG. As of 1997, the verified history of essential hypertension was associated with 1987 dioxin, and the evidence of prior myocardial infarction from the ECG was associated with initial dioxin. These findings, in conjunction with the increase in the number of deaths caused by diseases of the circulatory system for Ranch Hand nonflying enlisted personnel based on the 1994 AFHS mortality update (34), showed associations with dioxin that require further observation. A biological mechanism for the relation between dioxin and heart disease is unknown at this time.

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